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ENVIRONMENTAL ANALYSIS CONCERNING ICP COAL BENEFICIATION PLANT FOR IOWA COAL RESEARCH PROJECT

James B. Gulliford and Michael M. Crow

MINING AND RESTORATION DIVISION

APRIL 27, 1976

IOWA STATE UNIVERSITY Ames, Iowa 50011

ENVIRONMENTAL ANALYSIS

concerning

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by

James B. Gulliford

and

Michael M. Crow

MINING AND RESTORATION DIVISION

Lyle V. A. Sendlein
Assistant Division Chief

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R. S. Hansen, Director
Ames, Iowa 50011

ABSTRACT

This report is an environmental analysis of the Iowa Coal Project Coal Beneficiation Plant in Ames, Iowa. Based on site monitoring and a review of related literature, this report analyzes the impact of the beneficiation plant on the natural environment.

The present environmental features are described and evaluated with particular emphasis on existing surface and groundwater quality. The component processes of the beneficiation plant are presented and the plant environmental design features are described.

The beneficiation plant is not expected to have a significant impact on the area but the development of a coal beneficiation technology in the State of Iowa can be expected to significantly impact the Iowa coal mining industry. Research needs in expectation of this development are offered in the report.

TABLE OF CONTENTS[a]

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

(a) The outline used for this report is developed from Battelle Laboratories, Reference (4).

LIST OF TABLES

LIST OF FIGURES

PREFACE

This report was prepared in conjunction with the Iowa Coal Project. Supported by funds appropriated by the 65th General Assembly of Iowa, 1974, to the Iowa Coal Research Project, Iowa State University, this research was supervised by Dr. Lyle V. A. Sendlein, Assistant Division Chief of the Mining and Restoration Division. Kathy Moore, a graduate student in Plant Pathology, and Paul Calame and Janet Voight, participants in the University Year for Action program assisted at various stages of this research.

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1. INTRODUCTORY MATERIAL

1.1 General

The environmental analysis presented in this report, together with the detailed description of the ICP Coal Beneficiation Plant, has been prepared to facilitate the evaluation of the Iowa Coal Project - Coal Beneficiation Plant (ICP-CBP) as specified in Section 102 of the National Environmental Policy Act of 1969 (Public Law 91-190), the Guidelines of the Council on Environmental Quality, dated April 23, 1971 (36 F.R. 7724), and Order No. 415-B of the Federal Power Commission, issued November 19, 1971 (36 F.R. 22738). This study includes a preliminary examination of the existing environmental features of Ames, Iowa, particularly in the vicinity of the Iowa State University Power Plant. Included are detailed descriptions of the coal beneficiation plant and supporting components of its operation, including the movement of coal from the mine site to the plant.

1.1.1. Background

The Iowa Coal Research Project is funded by the legislature for a three year period beginning July 1, 1974. It is administered by the Energy and Mineral Resources Research Institute (EMRRI) at Iowa State University. The legislative act (S.F. 1362) calls for EMRRI to carry out research to determine whether Iowa coal can be mined economically and in an environmentally acceptable manner, and to investigate and demonstrate methods for improving the quality of Iowa coal by the removal of impurities. The research includes the study of the economics of coal production and transportation, investigation and development of new exploration methods, demonstration of improved land restoration techniques, and investigation of additional potentially useful by-products which might be produced in conjunction with a coal mining operation.

1.2 Coal Beneficiation Plant

The primary goal of the beneficiation portion of the Iowa Coal Project is to establish methods for beneficiating Iowa coal so that it can be burned in conformance with environmental standards and to demonstrate these methods on a sufficiently large scale to permit reasonable estimates of their costs.

1.3 Need for Project

The need for this project is based primarily on the State of Iowa's need for an inexpensive, environmentally safe energy source. As mentioned previously, a portion of the research being undertaken by the ICP is concerned with the economic extraction of coal. The problem is that typically high sulfur levels of Iowa coal do not meet present environmental standards. Within the Beneficiation Division, washability studies have been completed on the coals from mines throughout the state (Table 1.1). The results of this study show that Iowa coal characteristics vary widely, with sulfur levels ranging from 2% to 8%. High sulfur Iowa coal must somehow be cleaned for the coal to meet environmental standards specified by the Environmental Protection Agency (EPA) and the Iowa Department of Environmental Quality.

1.4 Application of National Environmental Policy Act to Project

The evaluation of the impact of the ICP coal beneficiation plant on the environment and the discussion of alternative actions to the plan were made in accordance with the National Environmental Policy Act. The information contained in Chapters 2 and 3 of this report provide the basis for the environmental characteristics and conditions used to develop the conclusions set forth later in this report.

TABLE 1.1

Washability Results of Seven Iowa Coals Cleaned at a Specific Gravity of 1.50[a]

Mine	Raw Coal Heating Value BTU/lb.	Clean Coal Heating Value BTU/lb.	Percent Weight Recovery	Percent BTU Lost in Refuse	Percent Sulfur Raw Coal	Percent Sulfur Clean Coal	Percent Ash Raw Coal	Percent Ash Clean Coa
ICO	11,966	12,194	93.6	4.62	2.88	2.14	8.8	7.0
Lovilia #4	11,139	11,567	90.8	5.71	3.89	2.27	12.0	8.6
Big Ben	11,205	11,526	93.7	3.61	4.41	3.48	9.4	6.8
Jude	10,398	11,256	87.4	5.39	7.05	5.50	13.2	10.4
Mich	11,701	12,198	86.6	9.72	7.33	4.91	14.9	11.3
Otley	10,406	11,264	83.3	9.83	7.72	5.21	14.9	10.2
ICP #1	11,179	11,738	89.4	6.13	7.20	5.06	14.3	10.0

(a) Iowa Coal Research Project Progress Report, January 15,1975 to January 15, 1976.

2. EXISTING NATURAL ENVIRONMENTAL FEATURES

2.1 Physical and Chemical

2.1.1 Land

a. Location

(1) Construction Site

The construction site of the ICP-Coal Beneficiation Plant is located on the campus of Iowa State University on the west side of Ames, Iowa (Story County), 32 miles north of Des Moines, Iowa. The site lies 200 feet northeast of the ISU power plant. The site contains 3 acres in the NW 1/4 of section 4, Tier 83 N, Range 24 W. It is bounded by Sixth Street on the north, the ISU power plant on the west, the power plant railroad spur on the south, and several acres of unused university property on the east.

Figures 2.1 and 2.2 show the construction site and its location with respect to the impact area and the City of Ames.

(2) Impact Area

The impact area is a 320 acre site surrounding the ICP-CBP construction site. It is bounded by 13th Street on the north, Iowa State University on the west, Lincoln Way Avenue on the south, and residential Ames on the east (Figure 2.1).

b. Topography

The main drainage of the impact area is Squaw Creek which flows southeasterly 1/2 mile east of the construction site Surface drainage of the construction site flows from the northwest with nearly all surface runoff being deposited in a drainage ditch that flows east, along the south edge of the CBP site into an intermittent stream that flows into Squaw Creek. The topography of the ICP-CBP area is shown in Figure 2.3.

c. Soils

The principal soil of the beneficiation plant area is Colo silty clay loam. This soil is a dark colored, poorly drained, bottomland soil developed in moderately fine textured alluvium. Colo soils have moderately slow permeability and are usually wet due to a high water table. They are subject to occasional flooding and standing water.

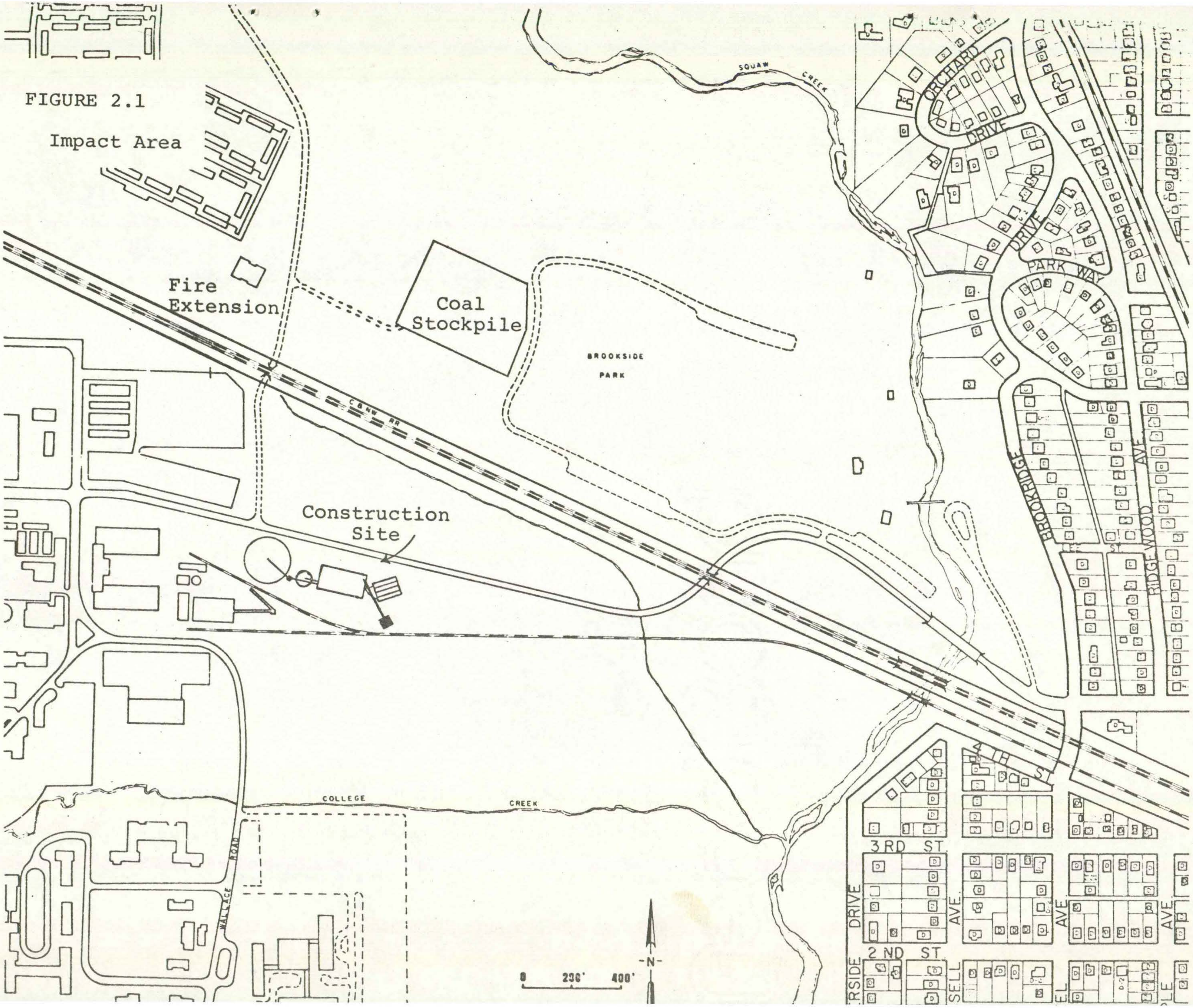


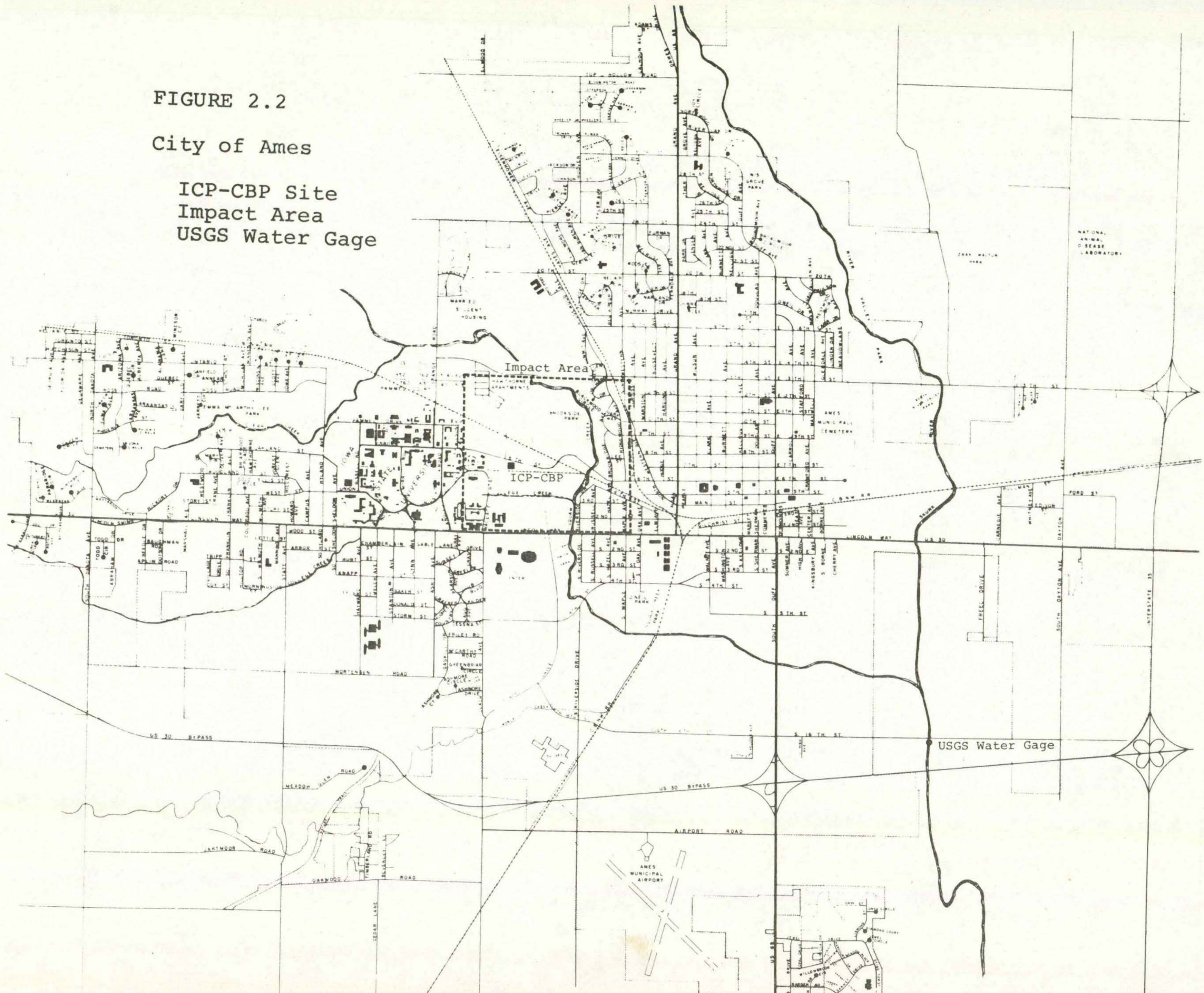
FIGURE 2.1

Impact Area

FIGURE 2.2

City of Ames

ICP-CBP Site
Impact Area
USGS Water Gage



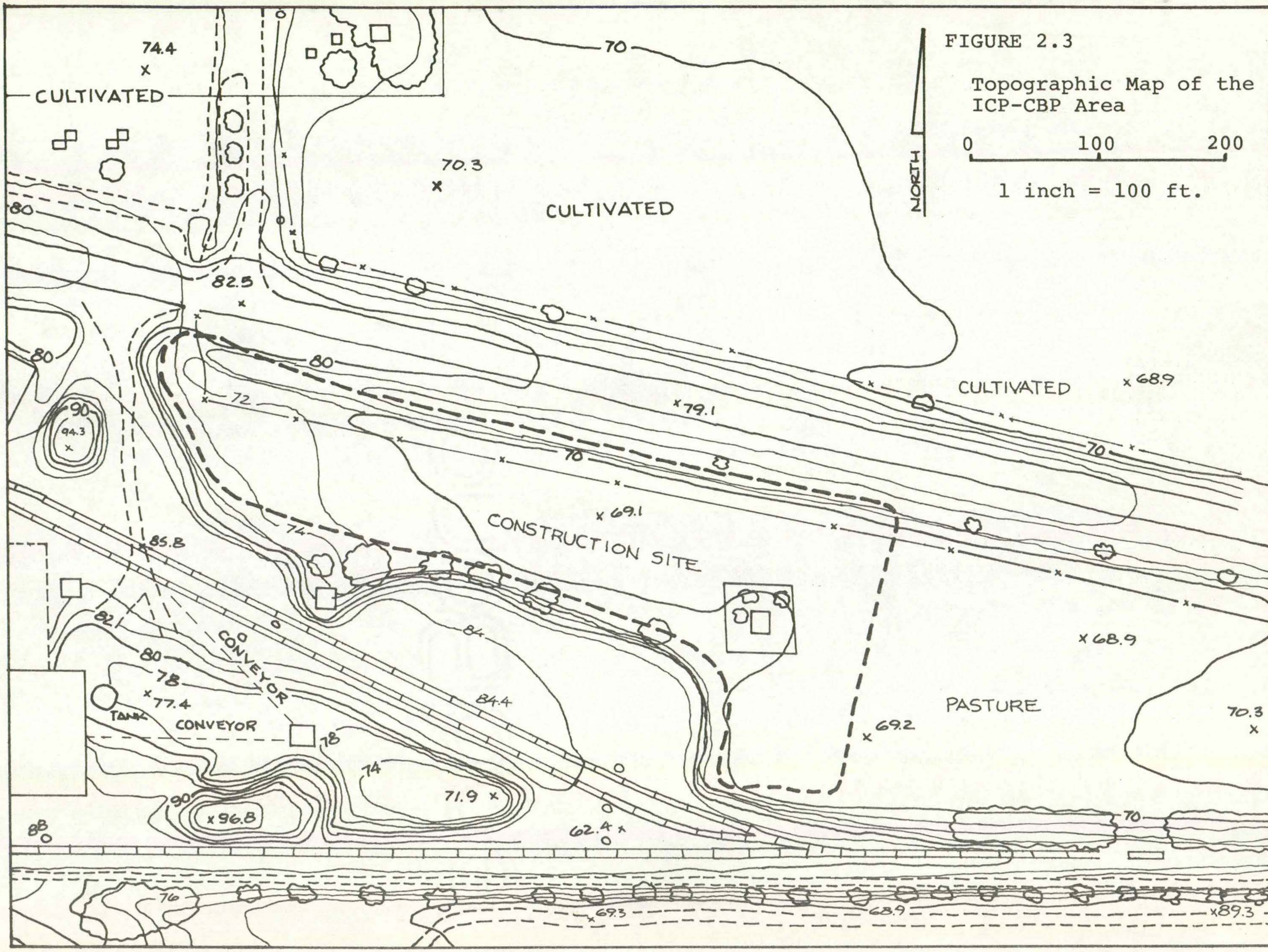


FIGURE 2.3

Topographic Map of the ICP-CBP Area

Were the beneficiation site not in an urban area, the Colo soil of the site would be well suited for agricultural use. Organic matter is high, subsoil phosphorus medium, and subsoil potassium is low. The pH ranges from 6.0 to 7.5 over the soil profile. The crop potential is good and row crops can be planted yearly if tile drainage is provided and fertilization needs are met.

The poor drainage and periodic flooding of the Colo soil limit its use for residential and industrial development. These limitations were considered in the engineering design of the Coal Beneficiation Plant. The USDA Soil Conservation Service ratings of Colo soil with respect to its resource use are in Table 2.1. (23)

2.1.2 Air

a. Climatology

(1) General

Central Iowa, located in the heart of the North American landmass, has a climate which is continental in nature. In winter, the mean pressure of the region is higher than that of the surrounding area causing a general outflow of cold, dry air. In summer, the pressure of the region is low, resulting in a general inflow of warm, moist air. The result is a marked seasonal contrast in both temperature and precipitation. (17)

(a) Wind

The annual wind chart for Central Iowa (Table 2.2) shows the frequency at which the wind blows from each direction by velocity groups. The gradiant from which the wind blows (greater than 12 MPH) most frequently is the northwest, 5.5% of the time. The largest percentage of wind, however, falls in the 0-12 MPH classification. This wind cannot be classified by direction because of extreme velocity variability and rapid directional change. 58.2% of all wind is in this category.

(b) Temperature

Monthly temperature means observed at the Ames Municipal Airport are given in Table 2.3. These data show a typical diurnal temperature range of 20° to 25° F. Temperature extremes recorded at the airport are midwinter -30° F and midsummer 110° F; 140° variation.

TABLE 2.1

Suitability of Colo Soil as a Resource Material[(a)]

SUITABILITY OF SOIL AS RESOURCE MATERIAL

Topsoil suitability: Fair to good; high organic matter; seasonal high water table; slightly high in clay.

Sand and gravel: Not suitable.

Road fill suitability: Very poor; high organic matter; poor bearing capacity and shear strength; high volume change.

Major soil features affecting use for:

Highway location: Seasonally high water table; subject to flooding; high organic matter; highly elastic.

Pond reservoir area: Moderately slow permeability; high in organic matter.

Agricultural drainage: Moderately slow permeability; seasonal high water table; tile drainage feasible.

Terraces and diversions: Generally not needed due to topography; little or no limitation of soil material for diversions.

Degree of limitation and major soil features affecting use for:

Foundations for low buildings: Severe limitations; seasonally high water table; poor bearing capacity and shear strength; high volume change.

Septic tank disposal fields: Severe limitations; seasonally high water table; subject to flooding; questionable percolation rates.

Sewage lagoons: Severe limitations; moderately slow permeability; seasonally high water table; subject to flooding; high in organic matter.

Degree of limitation and soil features affecting Land Use planning:

Agricultural farm crops: Slight limitations when drained and protected from flooding, moderate if not.

Residential development with public sewer: Severe limitations; poorly drained; subject to flooding; seasonally high water table.

Residential development without public sewer: Severe limitations; poorly drained; subject to flooding; seasonally high water table.

Buildings for light industrial and commercial use: Severe limitations; poorly drained; subject to flooding; seasonally high water table.

RECREATION

Degree of limitation and soil features affecting use for:

Cottages and utility buildings: Severe limitations; poorly drained; subject to flooding; seasonally high water table.

Intensive camp sites: Severe limitations; poorly drained; subject to flooding; slow to dry after rain.

Picnic areas: Moderate to severe limitations; occasionally flooded during use period; slow to dry after rains; poorly drained.

Intensive play areas: Moderate to severe limitations; occasionally flooded during use period; slow to dry after rains; poorly drained.

Paths and trails: Moderate limitations; occasionally flooded during use period; slow to dry after rains; poorly drained.

Golf fairways: Moderate to severe limitations; occasionally flooded during use period; remain soft and wet for moderate periods.

The soil is evaluated only to a depth of five feet or less. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with good management and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.)

USDA SCS LINCOLN, NEBR. 1969 5, O--26849

(a) Soil Survey Information and Interpretations, USDA.

TABLE 2.2

Des Moines, Iowa Wind Data, Percentage of Occurrence by Wind Speed Class[a]

Direction	0-12	12-15	15-18	18-24	24-31	31-38	>38	Total
N		1.0	1.4	0.9	0.2			3.5
NNE		0.7	1.1	0.5	0.1			2.4
NE		0.5	0.7	0.2				1.4
ENE		0.3	0.5	0.2				1.0
E		0.4	0.5	0.1	0.1			1.1
ESE		0.5	0.7	0.2				1.4
SE		0.8	1.1	0.3				2.2
SSE		0.9	1.3	0.4	0.1			2.7
S		1.2	1.8	0.7	0.1			3.8
SSW		1.0	1.5	0.7	0.1	0.1		3.4
SW		0.6	0.9	0.5	0.1	0.1		2.2
WSW		0.5	0.7	0.4	0.1			1.7
W		0.4	0.7	0.4	0.1			1.6
WNW		0.8	1.3	1.0	0.5	0.2		3.8
NW		1.2	1.7	1.7	0.7	0.1	0.1	5.5
NNW		0.9	1.4	1.3	0.4	0.1		4.1
Calm	58.2							58.2
Total	58.2	11.7	17.3	9.5	2.6	0.6	0.1	100.0

(a) National Oceanic and Atmospheric Administration, Ashville, North Carolina.

TABLE 2.3

Average Temperatures °F, Ames, Iowa Airport[a]

	J	F	M	A	M	J	J	A	S	O	N	D
Max.	29.0	32.9	43.4	60.5	72.0	81.1	86.5	83.9	76.3	65.2	46.5	33.7
Mean	20.0	23.9	34.2	49.1	60.5	70.2	74.8	72.7	64.3	53.3	36.7	25.1
Min.	11.0	14.9	24.9	37.7	49.3	59.3	63.1	61.5	52.3	41.3	26.8	16.5

TABLE 2.4

Average Precipitation in Inches, Central Iowa[a]

Annual	J	F	M	A	M	J	J	A	S	O	N	D
31.46	1.13	1.12	1.92	2.86	4.29	4.65	3.39	3.52	3.43	2.39	1.57	1.19

(a) National Oceanic and Atmospheric Administration, Ashville, North Carolina.

(c) Precipitation

Precipitation averages 31.46 inches annually, but the yearly variation can be large, ranging from 17.1 inches in 1956 to 56.8 inches in 1881. Monthly precipitation amounts also have shown great variation historically, ranging from .03 inches in October, 1952 and November, 1969 to 15.79 inches of rainfall in June, 1881.

Average yearly snowfall is 30.1 inches but here, as with rainfall, wide variations exists. The winter of 1965-66 had 8 inches of snow compared to 70 inches in the winter of 1911-12. The central Iowa precipitation data in Table 2.4 are based on a 40 year record from 1935-1974 although individual records go back much further. (17)

b. Air Quality

(1) Ambient Air Quality Standards

The environmental Protection Agency (EPA) has promulgated national primary and secondary ambient air quality standards, as required by the Clean Air Act of 1970, for six pollutants: suspended particulate matter, sulfur oxides, carbon monoxide, photochemical oxidants, non-methane hydrocarbons, and nitrogen oxide (Appendix A).

Coal preparation plants fall directly under section 111 of the Clean Air Act, as amended, and regulations concerning their emission of pollutants are found in Title 40, Part 60, Subpart Y, of the Code of Federal Regulations. The regulations are in Appendix A.

(2) Existing Sources and Emissions

Iowa's current pollution control regulations, dealing specifically with sulfur dioxide levels, limit the burning of coal to coal with a three percent sulfur content. At the present time, this limit is uniformly applied to all coal burning facilities in Iowa by the Department of Environmental Quality. However, a recent research project examining individual power plants and their pollutants has determined the allowable sulfur levels to range from 0.52% to greater than 6.0%. This means that at a few locations within the state, a regulation more restrictive than 3% is warranted, but in the majority of cases, a less restrictive regulation could be applied (Appendix B).

(3) Observed Ambient Air Quality

Observations to date of existing air quality in the Ames area have not been adequate to describe either the concentrations or effects of existing pollution sources. Until such time that records are recorded from several locations over a period of time, the ambient air quality of Ames cannot be documented with assurance.

(a) Current Data

Suspended particulates and sulfur dioxide data are in Table 2.5. These data, collected for six months at the Fire Extension Building located 1/4 mile northwest of the ICP-CBP site (Figure 2.1), indicate to some degree the present air quality of the impact area. It is difficult to draw conclusions from the data presented because the Fire Extension Building is usually upwind of the power plant. There is additional monthly variation due to climatic conditions. (11)

c. Noise

There are two catagories of noise standards: "those standards which are intended to protect workers from hearing loss caused by exposure to excessive noise levels, and community noise standards which are designed to insure that the utility of property is not impaired by intrusive noise and also to protect inhabitants against physiological effects, such as hearing loss, stress, and loss of sleep". (4)

Under present zoning regulations, the CBP site does not fall under local standards governing noise.

The Occupational Safety Health Act (OSHA) represents the statutory authority of the federal government to protect workers from hearing loss that may result from exposure to noise. OSHA noise limits (Table 2.6) establish noise duration limits for decibel ranges from 90 dBA to 115 dBA. Noise levels above 115 dBA are not permitted. (14)

The ICP-CBP will operate under the conditions set forth by OSHA insofar as noise exposure of employees is concerned. These regulations will be administered by the Mining Enforcement and Safety Administration (MESA) as set forth in the Federal Coal Mine Health and Safety Act of 1969 (Public Law 91-173).

TABLE 2.5

Air Quality in Ames, Iowa
Fire Extension Building 1974[a]

Date	Suspended Particulate Conc. μg/m^3	Sulfur Dioxide Conc. μg/m^3
Jan. 11	24.2	70.6
Jan. 17	35.7	00.0
Jan. 24	61.5	20.5
Feb. 4	91.5	2.6
Feb. 10	133.0	00.0
Feb. 16	71.3	00.0
Feb. 22	49.9	9.9
Mar. 6	58.9	00.0
Mar. 12	27.4	00.0
Mar. 18	140.0	00.0
Mar. 25	46.5	12.5
Mar. 30	18.9	-
Apr. 5	38.2	00.0
Apr. 11	40.9	00.0
Apr. 17	71.1	00.0
Apr. 23	92.6	-
May 5	66.6	00.0
May 23	130.0	00.0
May 29	59.0	00.0
June 4	100.0	00.0
June 10	24.6	00.0
June 16	47.3	00.0
June 22	23.3	00.0

(a) Iowa Department of Environmental Quality

TABLE 2.6

Permissible Noise Exposures Prescribed by the Walsh-Healy Act[a]

Duration (hours/day)	8	6	4	3	2	1½	1	½	¼ or less
Permissible Sound Level (dBA)	90	92	95	97	100	102	105	110	115

Impulse or impact noise -- maximum permissible sound pressure level corresponds to a measured instantaneous peak value of 140 dBA.

(a) Walsh-Healy Act, Code of Federal Regulations.

(1) Noise Sources

(a) Natural

There are very few natural noise sources that occur in an area such as the CBP site. Although the site is in close proximity to a city park, industrial noise from the nearby ISU physical plant is predominant. There is little natural noise one associates with wind passing through trees and shrubs or bird and animal life.

(b) Man-Made

Because the ICP-CBP site is located at the western edge of a large, unoccupied flood plain, it cannot be considered located in a totally urban environment. However, industrial sources produce the dominant noise feature at the site. The university physical plant, its associated rail line and 6th Street are the noise sources of significant impact to the audible environment of the area.

It is estimated that sound pressure levels in the range of 65 dBA to 80 dBA could be experienced by observers in the vicinity of the CBP, the sound level being determined by the location of the observer relative to the beneficiation plant. Typical levels measured at a distance of 1000 feet during railroad car unloading range from 75 dBA to 77dBA -- during physical plant steam release from 68 dBA to 72 dBA.

A preliminary survey was made of sound levels at locations near the CBP site. Figure 2.4 shows the noise survey locations. Survey results are shown in Table 2.7. The average minimum noise level was 60 dBA.

2.1.3 Water

a. Hydrology

(1) Surface Water Systems

The ICP Coal Beneficiation Plant is located on an intermittent drainage of the Squaw Creek Sub-basin of the Skunk River Basin (Figure 2.2). Runoff from the site flows across the site from the northwest to the southeast and into the ISU physical plant blowdown drainage way. This 1200 foot drainage way exists at various places as a culvert or an open ditch.

FIGURE 2.4

Noise Baseline Measurements Locations

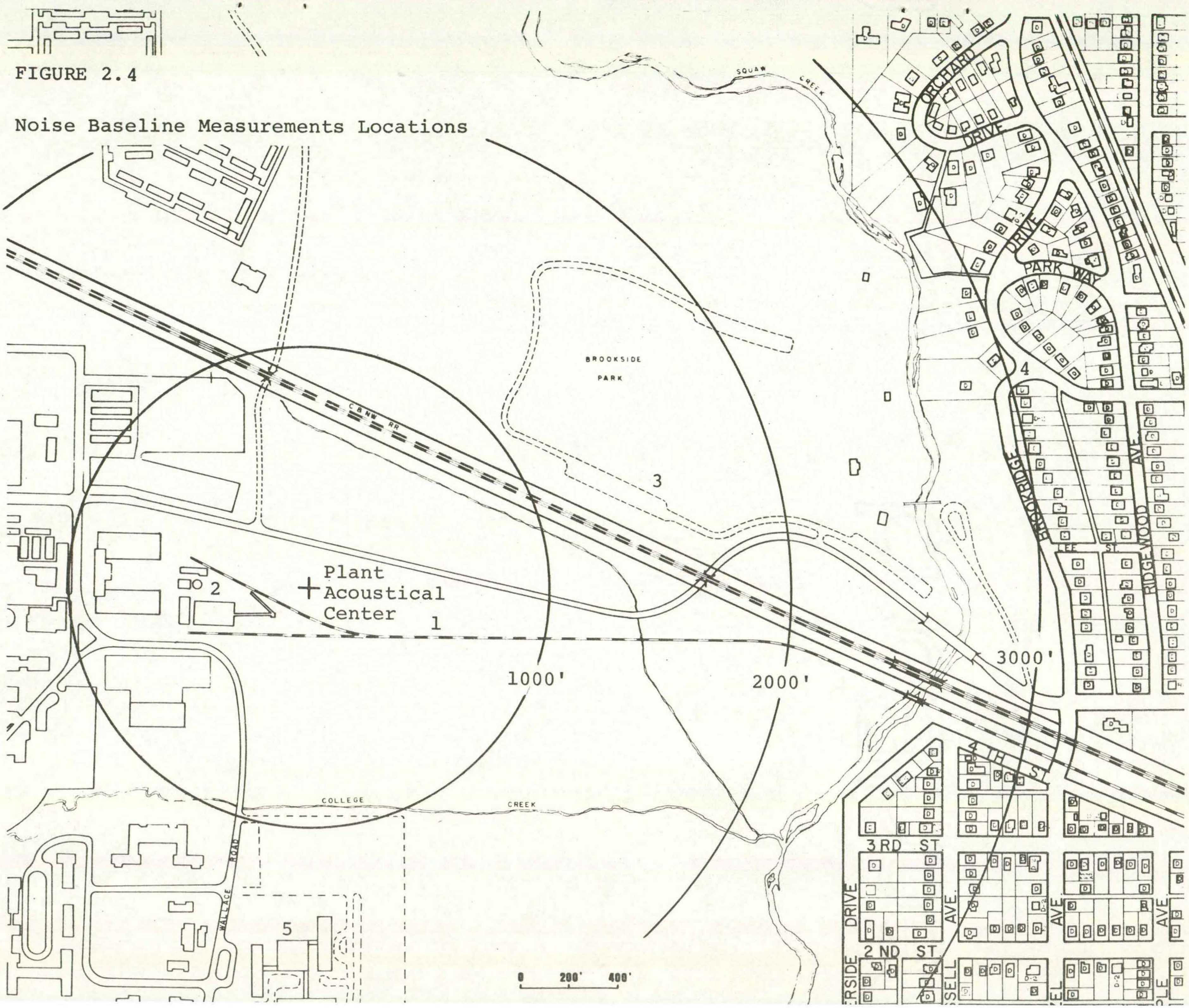


TABLE 2.7

Results of Noise Survey at Proposed Coal Beneficiation Plant Site (Sound Level Meter Readings 3/16/76)

Site	Location	Time	dBA Level
1	CBP Site 80 feet ESE of the proposed beneficiation plant	12:00 pm 5:00 pm 8:00 pm	68 68 64
2	ISU Physical Plant Yard 350 feet W of the proposed beneficiation plant	12:05 pm 5:05 pm 8:05 pm	80 76 70
3	Brookside Park 1600 feet ENE of the proposed beneficiation plant	12:10 pm 5:10 pm 8:10 pm	60 56 52
4	Intersection of Brookridge and 9th Street 3200 feet ENE of the proposed beneficiation plant	12:15 pm 5:15 pm 8:15 pm	56 52 50
5	Maple-Willow-Larch Dorm Complex 1600 feet S of the proposed beneficiation plant	12:20 pm 5:20 pm 8:20 pm	64 56 56

The drainage way receives daily 8,500 gallons of power plant boiler blowdown water, 4,500 gallons of water released from the cooling towers, and any runoff from precipitation. (8)

The drainage way enters the intermittent stream through a culvert and 800 feet later this stream flows into Squaw Creek. At this point the average flow rate of Squaw Creek is 107 ft^3/sec. Squaw Creek flows into the Skunk River 1 mile west of the U.S. 30 - Interstate 35 interchange. Here the average flow rate of the Skunk River is 269 ft^3/sec. (24)

(2) <u>Groundwater System</u>

The construction site is located within the Squaw Creek floodplain. Stratigraphy typical of the area is as follows:

(a) Surficial layer of partially oxidized alluvial silt, 5 - 10 feet in depth.

(b) Sand and gravel deposits ranging from 20 - 40 feet in thickness. These deposits constitute the unconfined or surficial aquifer of the University aquifer system.

(c) Clay silt layer 30 - 50 feet in thickness that acts as an aquatard between the surficial and confined aquifer.

(d) Confined aquifer 60 - 100 feet in thickness consisting of outwash Pleistocene sands and gravels. Clay lenses can be found suspended in this bed. (18)

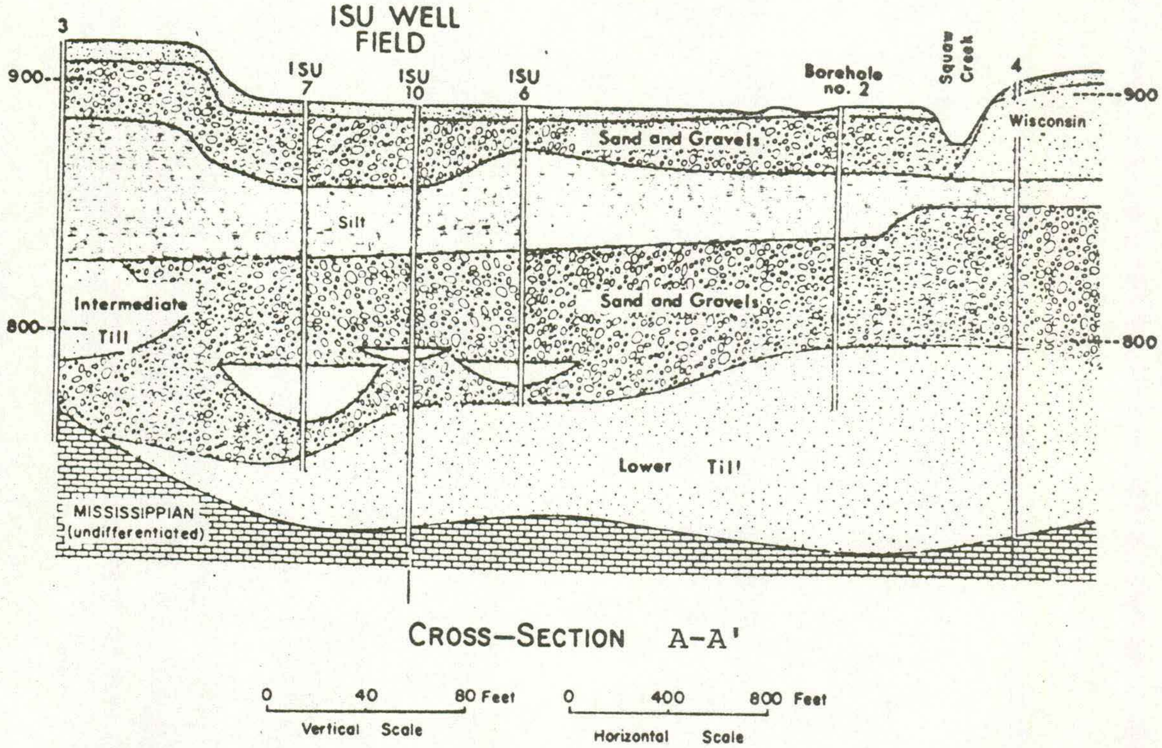
Figure 2.5 is a cross-section of the stratigraphy below the ICP-CBP construction site and Squaw Creek. The location of cross-section A - A' is shown in Figure 2.6.

The surficial aquifer is recharged by natural vertical infiltration from the land surface and direct recharge from Squaw Creek.

The confined aquifer is recharged by direct recharge from the surficial aquifer south of the study area (surficial and confined aquifer merge into one unconfined aquifer) and infiltration from the surficial aquifer through the overlying, confining silt layer. (18)

FIGURE 2.5

Stratigraphic Cross-section Below the ICP Beneficiation Plant[a]



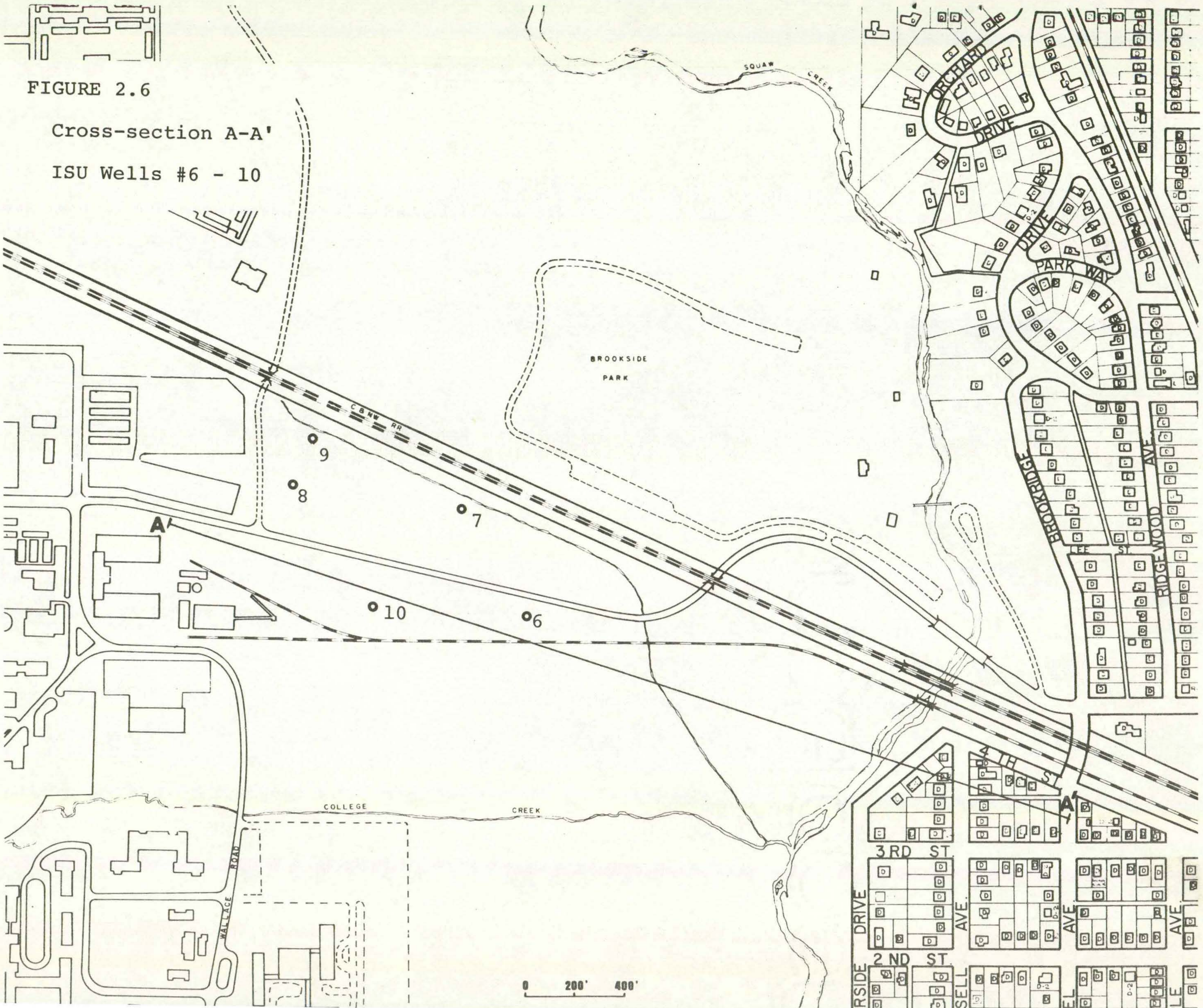
The ICP beneficiation plant is located 70 feet NW of ISU Well #10

(a) Nicklin, The Hydrogeology of the Regolith Aquifer Supplying the Iowa State University Well Field.

FIGURE 2.6

Cross-section A-A'

ISU Wells #6 - 10



Iowa State University pumps 2.25 MGD from the confined aquifer through the five ISU wells shown in Figure 2.6. This water is used in the university sanitation system. No pump data are available for the surficial aquifer. (8)

b. Water Quality

The Water Quality Act of 1965 was the principal legislative stimulus for the expansion of water pollution control programs. The Water Quality Act amended the Federal Water Pollution Control Act and Section 10 required the states to establish water quality standards for interstate streams within their boundaries by June 30, 1967. The Iowa water quality standards were set down by the Iowa Department of Environmental Quality in Chapter 455B of the Iowa Code (Appendix C).

(1) Existing Water Quality

Water quality in the CBP drainage area is poor. Degradation as far as chemical, physical, and biological quality is evident where the physical plant drainage way carries the effluents of the ISU physical plant boiler discharge into Squaw Creek.

(a) Surface Water Quality

Figure 2.7 shows the location of eight surface sites from which water samples were taken to characterize the surface water quality of the impact area. Table 2.8 is a detailed water quality analysis of sites 1-3 characterizing the physical plant boiler blowdown drainage.

Table 2.9 is a brief standard analysis of the intermittent stream and Squaw Creek water quality. Sites 4 and 5 are upstream and downstream of where the physical plant drainage culvert empties into the intermittent stream and sites 7 and 8 are upstream of where the intermittent stream empties into Squaw Creek. Site 6 is 1,000 feet upstream of site 7 but both are upstream of the physical plant and have similar water quality. A preliminary analysis of trace elements found at surface site 2 can be found in Table 2.10.

As noted earlier in the report, Squaw Creek drains into the Skunk River shortly after it leaves the CBP impact area. Therefore, included in Table 2.11 are data concerning the water quality of the Skunk River 0.2 miles downstream of Squaw Creek.

As indicated earlier the present surface water quality of the CBP impact area is poor. The Iowa State University Physical Plant, being the primary point source of this

FIGURE 2.7

Water Quality Sampling Sites

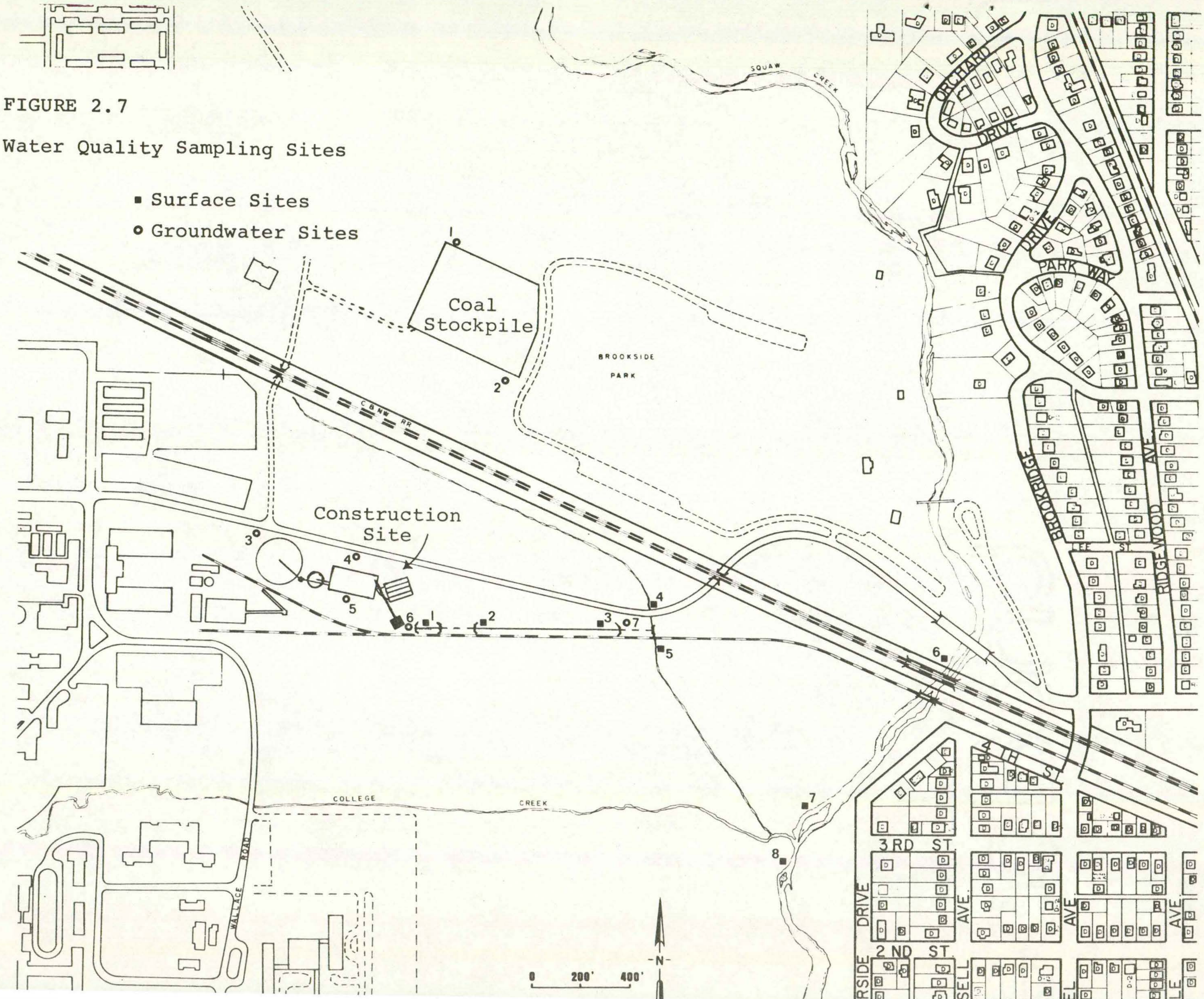


TABLE 2.8

Surface Water Quality, Site 1, November 11-20, 1975 [(a)]

Parameter	11-11	11-13	11-18	11-20	Minimum	Maximum
pH	8.35	2.4	8.4	8.65	2.4	8.65
Acidity (mg/l $CaCO_3$)	-	467	-	-	-	467
Alkalinity (mg/l $CaCO_3$)	217	-	194	192	-	217
BOD (mg/l O_2)	3.03	0.0	8.6	13.1	0.0	13.1
COD (mg/l O_2)	56.8	67.8	62.3	33.8	33.8	67.8
Total Solids (mg/l)	1074	1576	952	1030	952	1576
Total Volatile Solids (mg/l)	160	477	143	95	95	477
Suspended Solids (mg/l)	97	77	64	14	14	97
Volatile Suspended Solids (mg/l)	16	23	26	8	8	26
Fecal Coliform (organisms/100 ml)	TNTC*	280	400	310	280	TNTC
Total Coliform (organisms/1.0 ml)	1200	4000	1740	2400	1200	4000

(a) Analysis by Engineering Research Institute, Iowa State University, Ames, Iowa 50011

* TNTC = Too numerous to count

TABLE 2.8 (cont.)

Surface Water Quality, Site 2, November 11-20, 1975

Parameter	11-11	11-13	11-18	11-20	Minimum	Maximum
pH	8.35	2.4	8.4	8.65	2.4	8.65
Acidity (mg/l $CaCO_3$)	-	382	-	-	-	382
Alkalinity (mg/l $CaCO_3$)	208	-	207	186	-	186
BOD (mg/l O_2)	3.60	0.0	5.2	4.3	0.0	5.2
COD (mg/l O_2)	38.1	27.9	38.5	38.1	27.9	38.5
Total Solids (mg/l)	1093	1125	1024	2829	1024	2829
Total Volatile Solids (mg/l)	157	372	151	463	151	463
Suspended Solids (mg/l)	80	16	31	66	16	80
Volatile Suspended Solids (mg/l)	13	7	11	16	7	16
Fecal Coliform (organisms/100 ml)	270	42	40	110	42	270
Total Coliform (organisms/1.0 ml)	490	180	150	98	98	490

TABLE 2.8 (cont.)

Surface Water Quality, Site 3, November 11-20, 1975

Parameter	11-11	11-13	11-18	11-20	Minimum	Maximum
pH	8.35	2.4	8.4	8.65	2.4	8.65
Acidity (mg/l $CaCO_3$)	-	525	-	-	-	525
Alkalinity (mg/l $CaCO_3$)	217	-	194	192	-	217
BOD (mg/l O_2)	4.19	0.0	2.0	7.4	0.0	7.4
COD (mg/l O_2)	29.3	23.4	88.6	49.4	23.4	88.6
Total Solids (mg/l)	934	1191	1048	2465	934	2465
Total Volatile Solids (mg/l)	161	328	151	405	151	405
Suspended Solids (mg/l)	44	17	68	100	17	100
Volatile Suspended Solids (mg/l)	11	6	27	21	6	27
Fecal Coliform (organisms/100 ml)	130	16	95	100	16	130
Total Coliform (organisms/1.0 ml)	40	98	22	27	22	98

TABLE 2.9

Surface Water Quality, Sites 4 - 8[a]

Parameter	Sites 4	5	6	7	8
pH	8.8	8.7	8.6	8.6	8.8
Specific Conductance (μmho/sec.)	308	468	154	154	334
Alkalinity (mg/l $CaCO_3$)	250	230	130	130	140
Acidity (mg/l $CaCO_3$)	-	-	-	-	-
Sulfate (mg/l SO_4)	140	220	34	37	200
Total Dissolved Solids (mg/l $CaCO_3$)	737	876	382	382	811

(a) Analysis as described in Standard Methods for the Examination of Water and Wastewater

TABLE 2.10

Trace Element Analysis, Surface Site 2, December 15-17, 1975[a]
Concentrations in μg/l.

Element	12-15	12-16	12-17	Value Less Than
Ag				< 20
Al	52	36	200	
As				< 300
B	270	240	300	
Ba	340	240	280	
Be				< 2
Ca	280 E3	190 E3	160 E3	
Cd				< 10
Co				< 20
Cr				< 15
Cu	16	18		< 3
Fe				< 10
Hg				< 100
Mg	150 E3	100 E3	81 E3	
Mn	240		17	< 3
Mo				< 30
Ni				< 30
Pb				< 100
Sb				< 100
Se				< 300
Sn				< 300
Sr	900	800	780	
Ti				< 30
V			12	< 10
Y				< 2
Zn	290		66	< 20

(a) Analysis by Emission Spectroscopy, Ames Laboratory, ISU.

Note: An exponential format is used for high concentrations
eg. 280 E3 μg/l = 280×10^3 μg/l = 280 mg/l

Blank spaces indicate concentrations less than the value shown in the far right column

1% redistilled HNO_3 added to each sample as a preservative

TABLE 2.11

1973 Water Quality of the Skunk River at the U.S.G.S. Gage, (Map 1)[a]

Month	Mean Water Stage (ft)	No. of Samples	Water Temp. F	Dissolved O_2 mg/l	5 Day BOD mg/l	Suspended Solids mg/l	NH_2 mg/l	NO_3 mg/l	PO_4 mg/l
Jan	-	0	-	-	-	-	-	-	-
Feb	2.2	2	24	13.03	4.29	173	0.59	9.16	0.71
Mar	2.9	2	44	11.51	1.76	162	0.39	8.36	0.60
Apr	5.8	1	54	9.85	1.95	302	0.41	8.50	0.76
May	3.3	3	55	9.56	1.27	92	0.35	10.32	0.43
June	2.6	3	69	7.72	0.91	134	0.52	11.58	0.58
July	1.5	2	73	7.53	1.16	177	0.46	9.94	0.75
Aug	1.4	2	74	7.47	0.78	-	0.46	9.56	0.60
Sep	1.1	2	57	9.74	3.00	-	0.64	9.40	0.60
Oct	2.5	2	55	9.98	1.76	77	0.38	7.60	0.71
Nov	2.9	1	43	12.18	2.00	56	0.43	10.00	0.44
Dec	3.1	2	34	12.62	2.60	97	0.89	6.56	0.67

(a) Draft Environmental Statement for Veterinary Biologics Laboratory, Ames, Iowa. USDA

TABLE 2.11 (cont.)

1973 Water Quality of the Skunk River at the County Bridge, 3 miles S of the U.S.G.S. Gage

Month	Mean Water Stage (ft)	No. of Samples	Water Temp. F	Dissolved O_2 mg/l	5 Day BOD mg/l	Suspended Solids mg/l	NH_2 mg/l	NO_3 mg/l	PO_4 mg/l
Jan	-	0	-	-	-	-	-	-	-
Feb	2.2	2	34	12.64	6.07	194	0.72	8.84	2.39
Mar	2.9	2	44	11.40	1.72	159	0.53	9.12	0.82
Apr	5.8	1	54	9.65	2.85	304	0.37	8.90	0.85
May	3.3	3	55	9.50	1.32	127	0.38	10.90	0.63
June	2.6	3	69	7.58	1.03	133	0.71	10.66	0.76
July	1.5	2	73	7.38	1.30	165	0.64	9.50	0.98
Aug	1.4	2	75	7.85	1.46	-	0.80	9.03	0.80
Sep	1.1	2	58	9.40	3.78	-	1.20	8.60	1.10
Oct	2.5	2	56	9.78	2.50	77	0.44	7.50	0.82
Nov	2.9	1	43	11.97	3.23	64	0.80	8.95	0.72
Dec	3.1	2	35	12.42	3.92	114	1.10	7.05	0.79

pollution can at this time be held responsible for the present degradation of water quality near the CBP.

(b) Groundwater Quality

Groundwater sampling was completed in December 1975, its main purpose being to document the present groundwater quality in the CBP impact area. The test wells were located at various points throughout the impact area (see Figure 2.7) so that an analysis could be done on the impact of leachings of stockpiled Iowa coal and refuse. Standard and trace element test results are shown in Tables 2.12 and 2.13.

2.2 Biological Environment

2.2.1 Terrestrial

The CBP impact area is located in a semi-urban land setting, limiting its natural terrestrial habitats to very small areas, both in geographic size and wildlife population levels. As seen in Figure 2.1 the CBP impact area is composed of open pasture, wooded drainage ways, wooded bottom land, and urban areas. These are all heavily used by humans, limiting the number and diversity of species. (28)

a. Animals

(1) Reptiles and Amphibians

There were no reptiles or amphibians seen during the terrestrial investigations, a list of those species most likely to occur in the impact area can be found in Table D1 of Appendix D.

(2) Birds

Bird species seen or expected in the Coal Beneficiation Plant impact area are listed in Table D2 of Appendix D. Brookside Park (a wooded city park adjacent to the east of the CBP site) serves as a rest stop for many birds during spring and fall migrations.

(3) Mammals

A species list of mammals present in the CBP impact area is shown in Table D3 of Appendix D. The greatest diversity of mammalian fauna is found in the wooded Squaw Creek drainage area. Otherwise the area is most commonly inhabited by cotton-tail, thirteen-lined ground squirrels and fox squirrels.

TABLE 2.12

Groundwater Quality, December 17, 1975[a]

Parameter	1	2	3	4	5	6	7
pH	8.0	7.5	8.4	8.4	8.8	8.8	8.4
Specific Conductance (μmho/cm)	737	1640	1775	1050	855	1355	1029
Alkalinity (mg/l $CaCO_3$)	220	180	220	350	160	170	220
Acidity (mg/l $CaCO_3$)	-	-	-	-	-	-	-
Sulfate (mg/l SO_4)	150	260	250	220	220	240	200
Total Dissolved Solids (mg/l $CaCO_3$)	308	725	754	445	376	574	437

(a) Analysis as described in Standard Methods for the Examination of Water and Wastewater

TABLE 2.13

Groundwater Trace Element Analysis, December 17, 1975[a]
Concentrations in µg/l.

Element	1	2	3	4	5	6	7	Value Less Than
Ag								< 20
Al	36	70	80	90	540	50	36	
As								< 300
B	90	210	490	310	330	1100	330	
Ba	150	64	90	150	110	57	140	
Be								< 2
Ca	160 E3	350 E3	180 E3	200 E3	170 E3	150 E3	190 E3	
Cd								< 10
Co								< 20
Cr								< 15
Cu								< 5
Fe		140	20	60	800	40		< 10
Hg								< 100
Mg	85 E3	110 E3	54 E3	62 E3	35 E3	54 E3	93 E3	
Mn	300	6600	850	1100	710	390	300	
Mo								< 30
Ni								< 30
Pb								< 100
Sb								< 100
Se								< 300
Sn								< 300
Sr	210	360	670	370	360	340	330	
Ti								< 30
V								< 10
Y								< 5
Zn								< 20
K	-	6 E3	35 E3	7 E3	6 E3	6.4 E3	-	
Na	-	21 E3	130 E3	32 E3	25 E3	88 E3	-	

(a) Analysis by Emission Spectroscopy, Ames Laboratory, ISU.

Note: An exponential format is used for high concentrations eg. 160 E3 µg/l = 350×10^3 µg/l = 350 mg/l

Blank spaces indicate concentrations less than the value shown in the far right column

1% redistilled HNO_3 added to each sample as a preservative

Four traplines (consisting of from 20 to 30 snap traps) were run in the four major habitat types of the CBP impact area. Total captures per 100 trapnights equalled 6.82. This reflects an average abundance level. Species totals are found in Table D4. Totals by habitat are in Table D5.

(a) Endangered Species

No endangered species were found in the area.

(b) Recreational Species

Since the area is within the Ames city limits, no hunting is allowed, and therefore no recreational species are presented here. (28)

b. Vegetation

The site of the coal beneficiation plant is a combination of a mowed area with cultivated trees and a shrubby area along the drainage ditch. The mowed area is characterized by Kentucky bluegrass (Poa pratensis), dandelions (Taraxacum officirale), foxtail (Setaria spp.) and plantain (Plantago spp.). The white poplars (Populus alba) and two pines (Pinus spp.) are fully mature; the other pines are still saplings. (15)

Next to the cooling tower is a 2-3 foot area of weedy species, mainly thistles (Cirsium sp.). This strip is never mowed, allowing the weeds to grow higher than the bluegrass. The strip is green though the winter due to the warm spray of the cooling tower.

Along the north side of the drainage ditch is a narrow strip of herbaceous and shrubby weedy species. This strip is not mowed regularly. The south side of the drainage ditch, which is also the north slope of the railroad bed, contains many of the same species, with more shrub and tree species. These include, in addition to those found in the mowed area, ragweeds (Ambrosia spp.), brome grass (Bromus spp.), Virginia creeper (Parthenocissus quinquefolia), wild lettuce (Lactuca spp.),thistles (Cirsium spp.), sweet clover (Melilotus spp.), panic grasses (Panicum spp.), gooseberries (Ribes spp.), blackberries (Rusus spp.), roses (Rosa spp.), hackberry (Celtis occidentalis), boxelder (Acer negundo), American elm (Ulmus americana), walnut (Juglans nigra), ash (Fraxinus pennsylvanica), black cherry (Prunus serotina), and oaks (Quercus spp.).

The railroad tracks run immediately south of this area, and just south of them is a row of large cottonwoods (Populus deltoides).

The whole area is not particularly outstanding in terms of vegetation. Except for the cultivated species, everything is rather weedy and fast growing. One obvious asset, of course, is that it provides a small greenbelt along an otherwise lifeless drainage ditch and railroad bed. The plants also do a great deal to stop erosion along the slopes of the railroad bed and provide wildlife habitat for small mammals and birds. (15)

3. DESCRIPTION OF COAL BENEFICIATION PLANT

The overall project covered by this environmental statement consists of one research facility.

The research coal beneficiation plant will include two independent mechanical processing units, one chemical processing unit and all the auxiliary services required to convert high sulfur, high ash Iowa coal into an environmentally acceptable product at a rate of 70 tons/hour. The mechanical processing units will utilize methods of specific gravity separation to reduce the ash and sulfur levels. The chemical processing unit will utilize froth flotation to separate fine coal materials from impurities. Auxiliary equipment includes; crushers, conveyors, sizing devices, prewatering apparatus and a water recycling system.

3.1 General Background

Coal preparation encompasses the operation between the mining and distribution of the coal product. The various methods and their efficiencies are heavily dependent on the physical and chemical composition of a particular raw coal. Coal contains various quantities of sulfur, clay, rock, and ash which must be removed to meet environmental requirements. Analysis of these coal characteristics is a necessary prerequisite to choosing the most applicable method of beneficiation.

Preparation is accomplished through a variety of methods, including: mechanical, chemical, wet, dry and any combination of the above. Laboratory analysis of Iowa coals indicates that a combination of several cleaning methods will produce the highest yield of low sulfur and ash coal. As can be seen in the washability studies (Table 1.1) the coal found in Iowa mines has a wide range of characteristics which bring about the need for varied beneficiation equipment that can handle a wide variety of coal types.

There are various mechanical and chemical cleaning processes presently available but none are in use in Iowa. Mechanical processing of coal, such as float-sink processing, has been used for some time to reduce the sulfur and ash content of coal and it appears that Iowa coal can be processed by similar or improved methods.

A combination of three methods; dense-media separation, concentration tables and froth flotation cells were chosen for the ICP-CBP as processes that hold future value for Iowa coal cleaning and have the potential for development at this research facility.

3.2 Plant Process Design

3.2.1 Description of Coal Beneficiation Process

The process units to be incorporated in the beneficiation facility are briefly described below.

1. Heavy Media Separator. The Eagle Ironworks heavy media plant is designed specifically to be used in the cleaning of 1 1/2" - 3/8" lump sizes of coal. This process utilizes the difference in the specific gravities of coal and its impurities to achieve separation. The media slurry, a magnetite and water solution has a specific gravity which is between that of coal and the various impurities (sulfur, rock, shale). Operator controls permit adjustment of the specific gravity of the slurry to suit the cleaning requirements of various Iowa coals.

2. Concentration Tables. Dual deister concentration tables will be utilized to clean the finer coals (3/8" - 48 mesh). The processing unit is composed of separated vibrating tables. The controlled flow of water across the serrated table surface and table vibration effectively separate the coal from impurities.

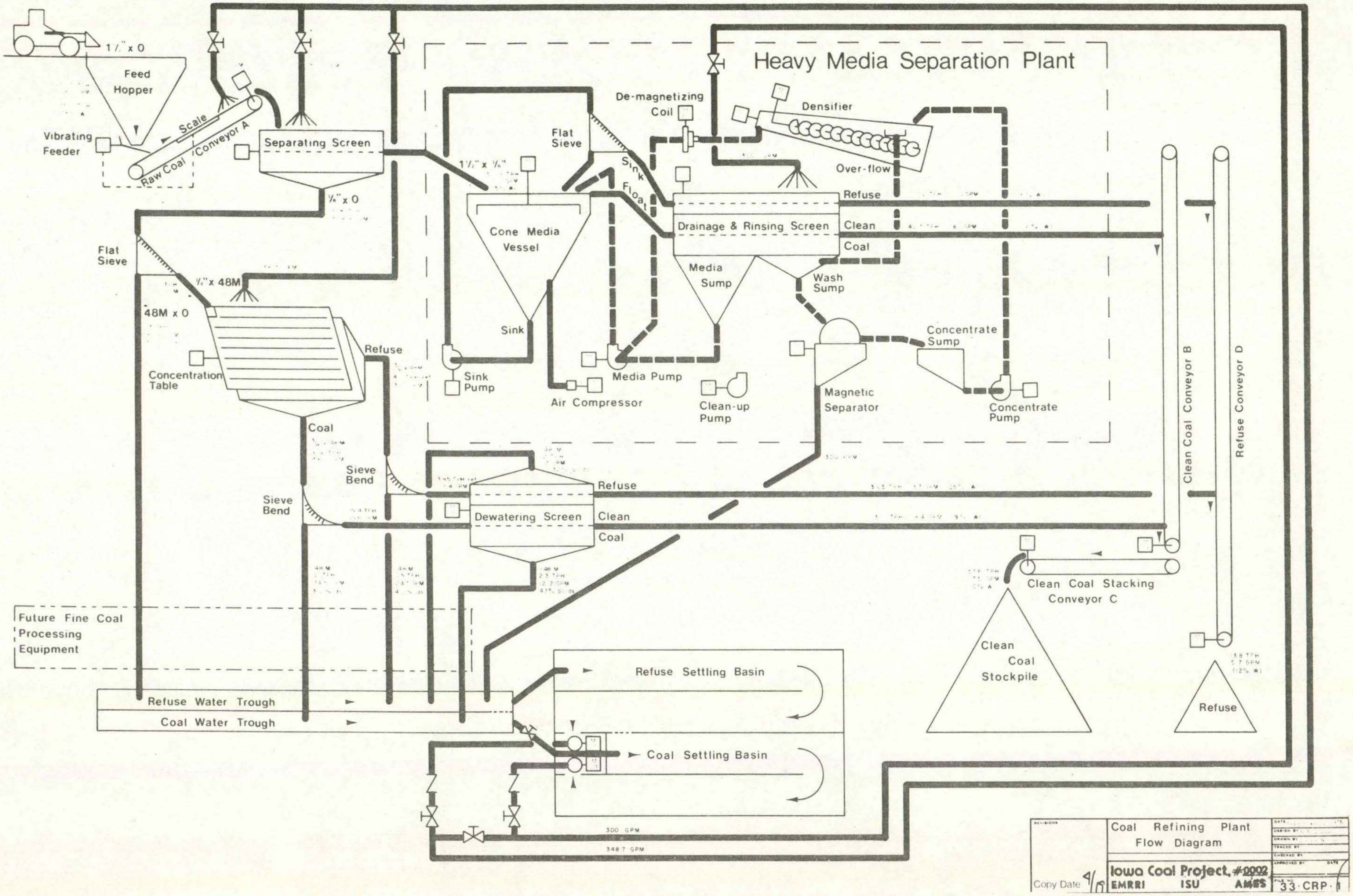
3. Froth Flotation. This process will be utilized to clean very fine coal particles (48 mesh and smaller) which are rejected by the concentration tables. Analysis has shown that as much as 5% of the total coal product may be found in this category. The process will utilize chemical agglomerates in slurry to separate coal from its impurities. Preliminary tests of froth flotation cells indicate the process can remove up to 40% of the total sulfur and reduce the ash level up to 50%. A limitation of this process is that coal cleaned by this method must be dried.

3.2.2 Flow Diagram

The schematic flow diagram (Figure 3.1) graphically depicts the heavy media separator and deister tables within the beneficiation plant. The future location of the froth flotation cells is also indicated.

FIGURE 3.1

ICP Beneficiation Plant Flow Diagram



3.3

3.2.3 Description of Component Process Units

a. Heavy Media Separator

The Eagle separation plant is a modified sand and gravel separator. The unit consists of a 10 foot diameter, cone shaped vessel with a hydraulic sweep agitator, sink/slurry scalping sumps, vibrating sizing screens, spray wetting equipment discharge chutes, operators platform and electrical control console, and supporting steel structure.

Located at the top of the heavy media plant is a pre-wetting and sizing screen. The vibrating screen channels wet 3/8" - 1 1/2" coal into the media slurry at the top of the media separation vessel. The media slurry, a controlled mixture of magnetite and 350 gallons of water is fed to the media vessel from the slurry-auger holding tank. The vessel's hydraulic agitator mixes the raw coal and media solution to facilitate efficient separation. Coal is skimmed from the rim of the vessel while impurities are removed below by media sump pumps. After separation, the clean coal and refuse materials are pumped to vibrating washing screens where the materials are drained, rinsed and dried naturally. Recovered media slurry from this first draining is pumped back to the separation vessel. Recovered media from a second rinse will be separated magnetically, the magnetite returning to the media sump or make-up tank, and water returning to the settling basin. Clean coal and refuse are conveyed to holding areas outside the plant facility.

b. Concentration Table Unit

Smaller coal materials 3/8"-48 mesh are washed on the dual deister concentration tables. The unit consists of two serrated, vibrating tables suspended from a steel structural frame. The tables are mounted one above the other with a raw coal feed to each table surface. The tables are slightly angled to facilitate process material movement across the tables. Coal materials, pre-sized and pre-wetted on the central feed screen (located above the heavy media plant) are slurried to the concentration tables, the raw coal drops onto the vibrating serrated surfaces, and table-side water jets wash the material. Table vibration and forced movement of water across the serrated surfaces effect material separation. The lighter coal will be bounced across the table surface and collected on one side. The heavier impurities are forced into the table separation grooves and are drawn to collection at the end of the tables. Materials are then screen dried and transported outside the facility via conveyors. Process water is sumped to the settling basin for recycling.

c. Froth Flotation

This is a future process. Methods are still under investigation and design.

d. Auxiliary Processing Units

Auxiliary processing units include a raw coal crusher for initial sizing, central feed sizing screens to separate and channel various coal sizes to their respective preparation processes, vibrating, dewatering screens to wash down and dry refuse materials and cleaned coal, media supply and recovery units, and a water supply and recovery system.

Other auxiliary equipment includes conveyors for handling, coal pre-wetting systems, effluent water treatment and re-use system, media safety systems, storage tanks, loading systems, and electrical, gas and water distribution systems.

3.3 Plant Environmental Design

The initial parts of Section 3 have discussed the coal beneficiation plant process design. The purpose of this section is to summarize the plant environmental design.

The most important aspects of the beneficiation plant environmental design are those related to:

1. Water use and wastewater treatment.
2. Product and wasteproduct disposal.
3. Air emissions.
4. Noise levels.
5. Construction requirements.
6. Environmental studies.

3.3.1 Water Use and Wastewater Treatment

The ICP-CBP water system is a closed cycle system. When operating at a 70 ton/hour coal cleaning capacity, the new water required will be 20-60 gallon/minute (gpm). The actual process requirement is 750 gpm; 700 gpm coming from the plant recycling system and 20-60 gpm as water make-up due to loss. This water loss will occur primarily as evaporation from the cleaned coal stockpile, temporary refuse holding pile, and the settling basin.

Wastewater (water used in the coal cleaning process) will be collected in the return-water trench in the plant floor and gravity fed to the 100,000 gallon settling basin. This four-channel basin is designed to permit its utilization as a single, dual, or total recycling circuit. Process water in the settling basin will be purified by natural settling or with the aid of chemical flocculants. The clean water is then sumped back to the plant facility for re-use.

3.3.2 Product and Wasteproduct Disposal

Clean coal from the heavy media separator and deister tables will be transported from the beneficiation plant via a belted conveyor to a temporary storage pile outside the building. From here it can be taken to either the physical plant boilers or the large coal storage pile north of the site.

Waste from the coal beneficiation process will occur in two places; the temporary refuse holding pile and the bottom of the settling basin. The temporary refuse holding pile can only hold two days' waste. Present plans are to load the waste on trucks and return it to the Iowa Coal Project Demonstration Mine # 1 for burial there. Waste will be removed from the settling basin by channeling the wastewater through two channels of the basin, allowing the other two to dry and be cleaned by a front end loader. This waste will also be returned to the mine.

3.3.3 Air Emissions

All air emissions associated with the beneficiation plant are expected to be fugitive dust rather than point source emissions. The wet process of the cleaning plant will control dust once the coal enters the plant and all coal drying will by by natural evaporation. There are no thermal dryers associated with the beneficiation plant.

Fugitive dust problems are likely to occur at the coal handling points outside the plant; where it is dumped from trucks, crushed and loaded onto the conveyor that leads into the plant, and at the clean coal pile as it falls from the conveyor. A coal 'ladder' has been installed at the clean coal pile to control the fall of coal from the conveyor. This will result in less fracturing of the coal as it drops and less dust.

These operations will be observed and monitored if necessary to determine if a fugitive dust problem exists, and corrective measures will be taken to abate any problem.

3.3.4 Noise Emissions

The estimated noise potential of each major item of equipment (Table 3.1) is accounted for in this preliminary noise control design. This initial overall noise estimate will provide the plant designers with an idea of what noise reduction is necessary for each equipment item and which equipment operators require hearing protection. (5)

It appears that the coal crusher (exterior to the building) and the sizing and dewatering screens offer the potential noise problems associated with the plant. Designs to control plant noise could possibly include:

(a) Mufflers on vents, jets, compressor inlets and outlets, control valves, etc.

(b) Reducing air-fan noise by using more blades and lower speeds.

(c) Using totally enclosed motors or insulated wraps on motor cases.

(d) Inlet mufflers, insulated plenums, and/or insulated ducts for boiler burners.

(e) Insulated operating stations for full-time working exposure in areas above 90 dBA.

(f) Rubber decking on vibrating screens.

During and after plant start-up, plant noise levels will be monitored to determine what additional noise control features are required. (4,5)

The following goals for noise level limits within operating areas of the beneficiation plant have been established. (4)

Facility	Continuous Noise Limit in dBA
Control rooms and offices	55
Plant property line	65
Within 5 ft. of regular working area	85-90
Occasional working area	95
Remote areas within the plant	105

TABLE 3.1

Estimated Noise Levels for Coal Preparation Plants[a]

ICP Major Components	
Heavy Media Separator	75-85 dBA
Deister Tables	75-85 dBA
Froth Flotation Cells	75-85 dBA
ICP Auxiliary Processing Units	
Coal Crusher	90-105 dBA
Sizing Screens	95-105 dBA
Vibrating Dewatering Screens	95-105 dBA
Belted Conveyors	75-85 dBA

(a) U.S. Bureau of Mines PB-235 852, Coal Cleaning Plant Noise and its Control

3.3.5 Construction Requirements

3.3.5.1 Roads

One gravel access road will be constructed to connect the beneficiation plant with Sixth Street and the Iowa State University Physical Plant. This road will be used during construction by plant personnel, construction personnel and construction equipment. During plant operations, the road will be used by plant personnel and clean coal and refuse removal trucks. Raw coal will be brought to the beneficiation plant along the railroad berm south of the plant.

3.3.5.2 Storm Drainage

The beneficiation plant is situated on fill material approximately six feet above the hundred year flood level (Figure 3.2). Drainage for the site was considered in the construction cut and fill process. Surface drainage channels were cut on the north and south sides of the plant site. These channels run east where they merge and empty into the physical plant drainage way.

3.3.6 Environmental Studies

The environment of the plant worker will be monitored in the area of dust and noise control as required by the Mining Enforcement and Safety Administration (MESA). MESA requires that dust concentrations not exceed 2.0 mg/m^3 and noise levels and durations of exposure not exceed the OSHA noise limits of Table 2.6.

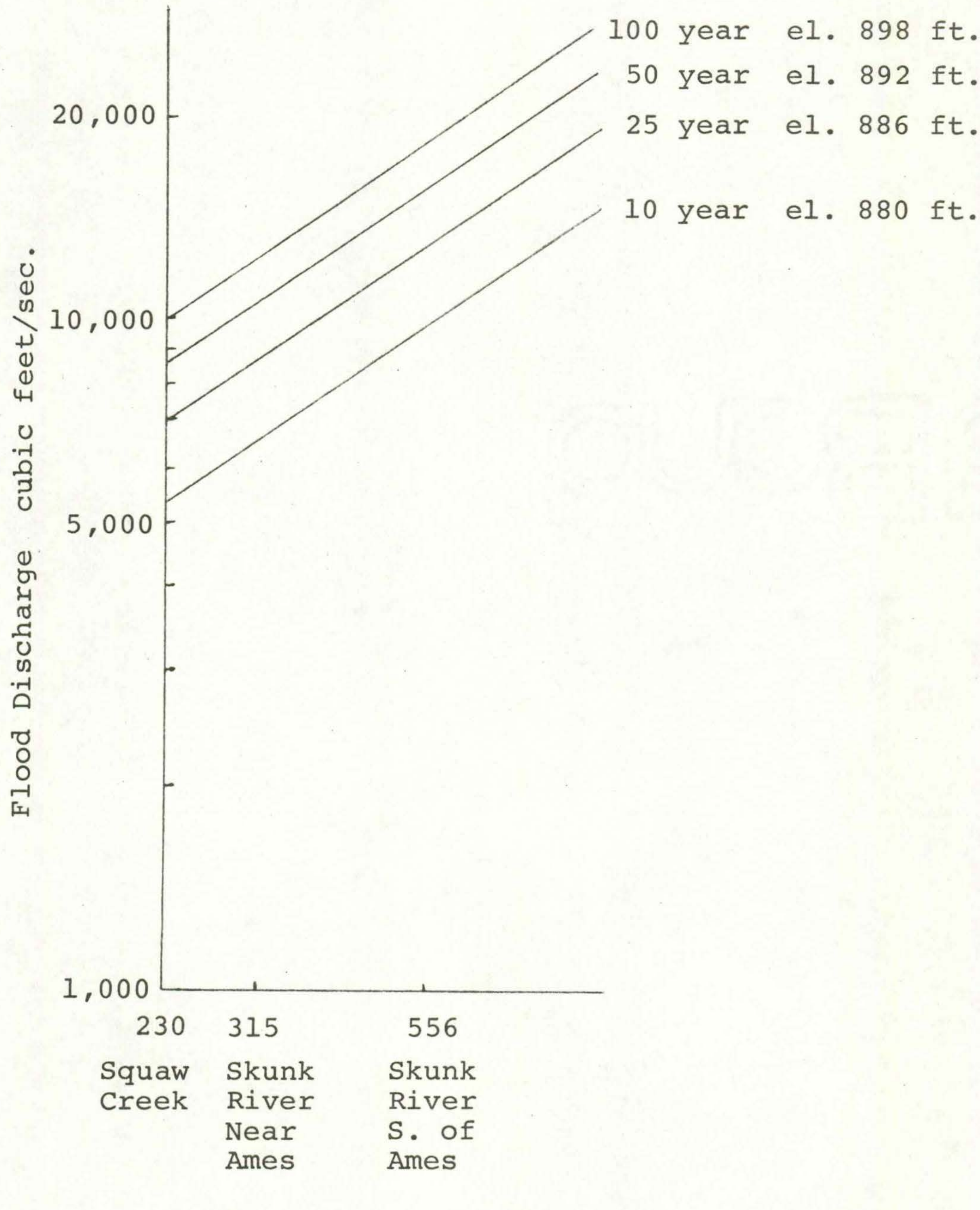
The groundwater wells and surface sampling sites established for the baseline environmental study will be maintained and monitored to determine any effect the beneficiation plant or beneficiation process may have on the aquatic environment of the site.

Should fugitive dust appear to be a problem, equipment is available to monitor the level of fugitive dust and the extent of its effect on the environment surrounding the site.

The temporary refuse holding pile will be on a concrete pad to control any runoff from the pile. This runoff would be expected to be high in sulfur and other trace elements. The CBP research site offers an opportunity to document what elements are present in this runoff and how refuse runoff must be controlled on a beneficiation site at a mine.

FIGURE 3.2

Flood Frequency, Magnitude, and Approximate Corresponding Flooded Surface Elevations for Squaw Creek at 6th Street[(a)]



(a) Vawter, 1963. Elevations and Frequency of Occurrence of Floods in Squaw Creek Basin in Ames.

4. IMPACT OF THE COAL BENEFICIATION PLANT ON THE NATURAL ENVIRONMENT

4.1 Physical and Chemical

4.1.1 Land

It can be expected that the land associated with the CBP construction site will be affected during the construction of the plant. Foundations for the plant proper and conveyor supports will be established, the settling basin will be dug into the ground, and areas for the clean coal and temporary refuse storage will be prepared. The establishment of a rock surfaced road connecting the plant with 6th Street will result in the compaction of the soil supporting the road. These permanent construction features will convert approximately one acre from grassy field to constructed area.

The existing topography of the area will be affected little by the construction of the beneficiation plant. The plant design instead incorporates the railroad berm into its plant layout. From this berm, raw coal can be dumped into the feed hopper and gravity-fed onto the conveyor leading into the plant.

4.1.2 Air

The truck traffic required to transport coal to the beneficiation plant will not be a significant source of additional air pollutants. Twenty-five truckloads of coal (22 tons coal/truckload) per day would meet the plant's 70 ton/hour capacity, however, the only consumer of the plant's clean coal will be the ISU physical plant. The physical plant consumes coal at 1/2 the cleaning plant's capacity (8 hr. shift/day for the cleaning plant) necessitating only 65 truckloads of coal to be delivered to the plant per week.

The internal operation of the CBP will have no impact on the local ambient air quality as the coal cleaning process is a wet process that will produce no fugitive dust.

The external support system, however, is expected to produce dust during the crushing and handling of the coal. Iowa Department of Environmental Quality estimates for uncontrolled fugitive dust emissions per ton of coal handled are as follows:

Coal crushing	0.5 lb/ton
Coal conveying and handling	2.0 lb/ton

Uncontrolled, coal handling could result in 1400 lbs. of fugitive coal dust emissions per day.

To minimize this dust problem and product loss, all external conveyors at the plant will be covered. The coal ladder will also reduce fugitive dust by breaking the fall of the clean coal from the conveyor. Dust control will be a problem at the beneficiation plant, its severity determined by the amount of coal processed daily, the atmospheric conditions (humidity, wind speed and direction) and dust controls built into the beneficiation plant system.

4.1.3 Water

The operation of the ICP-CBP, when considered as a unit, will require no aqueous discharge directly or indirectly into the Squaw Creek watershed. All contaminants will be allowed to settle out in the settling basin and the water will be recycled.

A potential source of water pollution will be the temporary refuse holding pile. This pile will consist of materials denser than coal: clays, shales, and pyrite. Until oxidation occurs, little sulfate sulfur will be present in coal. In coal waste piles however, crushed refuse is exposed to the air and oxidized, producing ferrous sulfate. It is important that a strict schedule for the removal of this refuse be established and followed. (12)

Were the refuse pile to permanently remain at the beneficiation plant, effluents similar to those from refuse piles in Illinois could be expected (Table 4.1). Runoff, following rains, from the temporary refuse pile will be monitored to determine if any leaching occurs that could affect the water quality of the Squaw Creek watershed.

4.1.4 Noise

Objectionable noise produced by the coal beneficiation plant operation should be confined to an area ranging from 100 to 1,000 feet from the plant. Because the city of Ames has no applicable standard for community noise, the levels at the arbitrary boundary of 1,000 feet will be dependent upon the amount of noise reduction required to meet the MESA standards set for noise levels within the plant.

People who reside near the impact area of the plant will not be adversely affected by any of the plant's noise emissions. The pre-plant ambient sound levels in the residential or recreational areas will remain unchanged because of the distance from the source.

TABLE 4.1

Analysis of Effluents from Refuse in Illinois
(all units mg/l except Conductivity, μmhos and pH, standard)[a]

Sample		pH	Cond.	Total Acidity[b]	SO_4	Total Fe	Fe^{++}	Total Solids
I1		3.6		640	1,200	55		8,570
I2		2.9		4,600	3,200	1,400		14,420
I3		3.3		6,100	2,800	50		16,830
I4		3.1		5,900	1,950	1,200		11,060
I5		2.8		8,700	3,550	4,600		13,860
I6		2.4		14,400	3,540	13,500		35,320
I7a	high	8.8	1,990	190	5,760	89	53	
	medium	6.6	1,080	-20	550	2.9	0	
	low	4.2	226	-550	80	0	0	
I7b	high	3.4	19,150	21,400	23,550	5,930	5,370	
	medium	2.65	6,370	6,500	6,100	1,510	1,160	
	low	2.05	875	500	625	115	89	
I8	high	3.54	24,100	25,700	28,600	7,820	7,560	
	medium	2.5	16,800	21,430	24,000	7,090	6,710	
	low	2.1	9,400	9,300	4,530	3,360	2,520	

(a) Martin, J. "Quality of Effluents from Coal Refuse Piles", US EPA.

(b) Acidity by Hot Hydrogen Peroxide Method E, ASTM D-1067 for samples I7a through I8.

4.2 Biological

The construction and operation of the coal beneficiation plant should have no significant effect on the biota of the area. This statement is based upon an estimate of the direction (beneficial or adverse) and magnitude of the effects on the various components of the biological environment. This estimate is made through an analysis of the number of undisturbed acres that will be affected. Because the site of the CBP will only directly affect three acres of an area already in industrial use, the number of direct effects upon the ecosystem is insignificant. The significant effect of the ICP-CBP is its establishment as a model for the development of coal beneficiation facilities throughout Iowa.

4.3 Technological and Economic Impact

The technological impact of the coal beneficiation plant, when applied to the Iowa coal industry, can be seen as follows:

The development of an economical and effective coal washing technology in Iowa would better enable Iowa coal to compete in Iowa's fossil fuel market. Although present Iowa coal production is approximately 1,000,000 tons/year, the October, 1975 Iowa Department of Environmental Quality report concerning the regulation of Iowa coal usage (Appendix B) indicates a potential market for 3.5% sulfur coal of 4,730,647 tons. The beneficiation process will not lead to a greater consumption of coal in Iowa, but rather a greater production and consumption of Iowa coal.

5. RECOMMENDATIONS FOR ENVIRONMENTAL STUDY

After the CBP begins its operation in May of 1976, it is the recommendation of this study group that the following aspects of the CBP environment be monitored to analyze any presently unknown adverse effects of the plant. It is also important to point out that the ICP-CBP is a research facility designed to determine the suitability of Iowa coal to various methods of cleaning. It was not designed to be a large scale industrial plant. Located in a different setting, this plant could possibly have a different effect on the local environment of a rural setting.

It is also important to note that there will be several additional cleaning processes added to the plant, each of which will have a different effect on the plant's relationship to the ambient environment.

5.1 Recommendations

5.1.1 Air Quality

With the future addition of a froth flotation device to the CBP it will become necessary to add a drying system. If thermal dryers are used to dry fine coal particles, the emissions from these dryers must meet the federal standards of 40 CFR, Part 60.252 (Appendix A, page A-11). Also, when considering the fact that future beneficiation plants may be placed in urban to semi-urban areas of south central Iowa, the control of fugitive dust becomes an important factor in the plant's operation. Both of the above mentioned effects on the ambient air quality should be monitored on a single plant scale, making note of air quality changes on a very localized basis. This research should be done on the ICP plant so that recommendations for future beneficiation plants can be made to the industry. See Appendix A for beneficiation plant regulations.

5.1.2 Water Quality

As mentioned in Chapter 4, the interior phase of the ICP-CBP operation is an entirely closed system through which no aqueous emissions will be made. However, the identification of potentially hazardous effects of a CBP in a south central Iowa setting has not been done. Therefore, it is important that continuous monitoring of both surface and groundwater quality be undertaken in order to ascertain whether or not the plant or its clean coal and refuse piles have any adverse impact on localized water quality.

5.1.3 Biological Environment

Future beneficiation plants may not be of similar scale and may be located in a rural setting. This change in setting would require environmental analysis to go into great detail on the ecological impact of a beneficiation plant. Therefore, a model for future studies should be completed using the operational ICP-CBP impact area.

5.1.4 Noise

Noise studies should continue after the plant has become operational to determine what noise impact the plant has on the quality of life in and around the ICP impact area. Future beneficiation plants may be located near residential areas and it will be important to know exactly what their effect will be. The noise levels inside the plant during operation should be monitored on a continuous basis for health and safety reasons, and because it is required by law.

5.1.5 Socio/Economic Environment

Because of the research nature of the ICP-CBP, the environmental analysis did not include a socio-economic study of its potential impact on the city of Ames. However, future plants in other regions of the state could have a significant effect on the human environment. Therefore, a model study of the human environmental impact of the CBP should be completed.

APPENDIX A

Air Quality Standards

Federal Ambient Air Quality Standards

Pollutant	Averaging Time	Maximum Concentration	
		Primary	Secondary
Suspended particulate matter	Annual	75 $\mu g/m^3$	60 $\mu g/m^3$
	24 hr	260 $\mu g/m^3$	150 $\mu g/m^3$
Sulfur oxides	Annual	0.03 ppm	0.02 ppm
	24 hr	0.14 ppm	0.10 ppm
	3 hr		0.5 ppm
Carbon monoxide	8 hr	9 ppm	9 ppm
	1 hr	35 ppm	35 ppm
Photochemical oxidants	1 hr	0.08 ppm	0.08 ppm
Nonmethane hydrocarbons	3 hr (6-9 a.m.)	0.24 ppm	0.24 ppm
Nitrogen oxides	Annual	0.05 ppm	0.05 ppm

As required by the Clean Air Act of 1970, the Environmental Protection Agency has established two types of standards. Primary standards are intended to protect public health, and secondary standards are to protect against effects on soil, water, vegetation, materials, animals, weather, visibility, personal comfort and well being.

Iowa Ambient Air Quality Standards

EMISSION STANDARDS FOR CONTAMINANTS

4.1 (455B) Emission standards. Performance standards for new or modified equipment as defined in 40 Code of Federal Regulations Part 60 (1972), shall be applicable as specified in this section. Compliance with emission standards specified elsewhere in this chapter shall be in accordance with chapter 2 of these rules. All standards in this chapter shall be considered as operation standards rather than design standards.

(1) Fossil fuel-fired steam generators. For fossil fuel-fired steam generators of more than 250 million BTU per hour heat input, the provisions of 40 Code of Federal Regulations Part 60 (1972) shall apply.

(2) Incinerators. For incinerators of more than 50 tons per day charging rate, the provisions of 40 Code of Federal Regulations Part 60 (1972) shall apply.

(3) Portland cement plants. For portland cement plants the provisions of 40 Code of Federal Regulations Part 60 (1972) shall apply.

(4) Nitric acid plants. For each nitric acid production unit the provisions of 40 Code of Federal Regulations Part 60 (1972) shall apply.

(5) Sulfuric acid plants. For each sulfuric acid production unit the provisions of 40 Code of Federal Regulations Part 60 (1972) shall apply.

4.2(455B) Open burning.

4.2(1) Prohibition. No person shall allow, cause or permit open burning of combustible materials, except as provided in 4.2(2) and 4.2(3).

4.2(2) Variances from rules. Any person wishing to conduct open burning of materials not exempted in subsection 4.2(3) may make application for a variance as specified in 3.2(1) of these rules.

4.2(3) Exemptions. The following shall be permitted unless prohibited by local ordinances or regulations.

a. Disaster rubbish. The open burning of rubbish, including landscape waste, for the duration of the community disaster period in cases where an officially declared emergency condition exists.

b. Diseased trees. The open burning of diseased trees. However, when the burning of diseased trees causes a nuisance, the commission may take appropriate action to secure relocation of the burning operation. Rubber tires shall not be used to ignite diseased trees.

c. Flare stacks. The open burning or flaring of waste gases, providing such open burning or flaring is conducted in compliance with paragraphs 4.3(2)d and 4.3(3)d of these rules.

d. Landscape waste. The disposal by open burning of landscape waste originating on the premises. However, the burning of landscape waste produced in clearing, grubbing and construction operations shall be limited to areas located at least one-fourth mile from any inhabited building. Rubber tires shall not be used to ignite landscape waste.

e. Recreational fires. Open fires for cooking, heating, recreation and ceremonies, provided they comply with paragraph 4.3(2)d of these rules.

f. Residential waste. Backyard burning of residential waste at dwellings of four-family units or less. The adoption of more restrictive ordinances or regulations of a governing body of the political subdivision, relating to control of backyard burning, shall not be precluded by these rules.

g. Training fires. Fires set for the purpose of bona fide training public or industrial employees in fire fighting methods, provided that the Executive Director receives notice in writing at least one week before such action commences.

4.3(455B) Specific contaminants.

4.3(1) General. The emission standards contained in this rule shall apply to each source operation unless a specific emission standard for the process involved is prescribed elsewhere in this chapter, in which case the specific standard shall apply.

4.3(2) Particulate matter. No person shall cause or allow the emission of particulate matter from any source in excess of the emission standards specified in this chapter, except as provided in chapter 5.

a. Process weight rate. The emission of particulate matter from any process shall not exceed the amount determined from Table I except as provided in 3.2(455B), 4.4(455B) and chapter 5.

b. Combustion for indirect heating. Emissions of particulate matter from the combustion of fuel for indirect heating or for power generation shall be limited by the ASME Standard APS-1, Second Edition, November, 1968, "Recommended Guide for the Control of Dust Emission--Combustion for Indirect Heat Exchangers". For the purpose of this paragraph, the allowable emissions shall be calculated from equation (15) in that standard, with $C_{omax}2 = 50$ micrograms per cubic meter. Allowable emissions from a single stack may be estimated from Figure 1. The maximum ground level dust concentrations designated are above the background level. For plants with 4,000 million BTU/hour input, or more, the "a" factor shall be 1.0. In plants with less than 4,000 million BTU/hour input, appropriate "a" factors, less than 1.0, shall be applied. Pertinent correction factors, as specified in the standard, shall be applied for installations with multiple stacks.

(1) Outside any standard metropolitan statistical area, the maximum allowable emissions from each stack serving existing equipment, irrespective of height, shall be 0.8 pounds of particulates per million BTU input.

(2) Inside any standard metropolitan statistical area, the maximum allowable emission from each stack, irrespective of height, shall be 0.6 pounds of particulates per million BTU input.

TABLE I
ALLOWABLE RATE OF EMISSION BASED ON
PROCESS WEIGHT RATE *

Process Weight Rate		Emission Rate	Process Weight Rate		Emission Rate
Lb/Hr	Tons/Hr	Lb/Hr	Lb/Hr	Tons/Hr	Lb/Hr
100	0.05	0.55	16,000	8.00	16.5
200	0.10	0.88	18,000	9.00	17.9
400	0.20	1.40	20,000	10.00	19.2
600	0.30	1.83	30,000	15.00	25.2
800	0.40	2.22	40,000	20.00	30.5
1,000	0.50	2.58	50,000	25.00	35.4
1,500	0.75	3.38	60,000	30.00	40.0
2,000	1.00	4.10	70,000	35.00	41.3
2,500	1.25	4.76	80,000	40.00	42.5
3,000	1.50	5.38	90,000	45.00	43.6
3,500	1.75	5.96	100,000	50.00	44.6
4,000	2.00	6.52	120,000	60.00	46.3
5,000	2.50	7.58	140,000	70.00	47.8
6,000	3.00	8.56	160,000	80.00	49.0
7,000	3.50	9.49	200,000	100.00	51.2
8,000	4.00	10.4	1,000,000	500.00	69.0
9,000	4.50	11.2	2,000,000	1,000.00	77.6
10,000	5.00	12.0	6,000,000	3,000.00	92.7

*Interpolation of the data in this table for process weight rates up to 60,000 lb/hr shall be accomplished by the use of the equation

$$E = 4.10 P^{0.67},$$

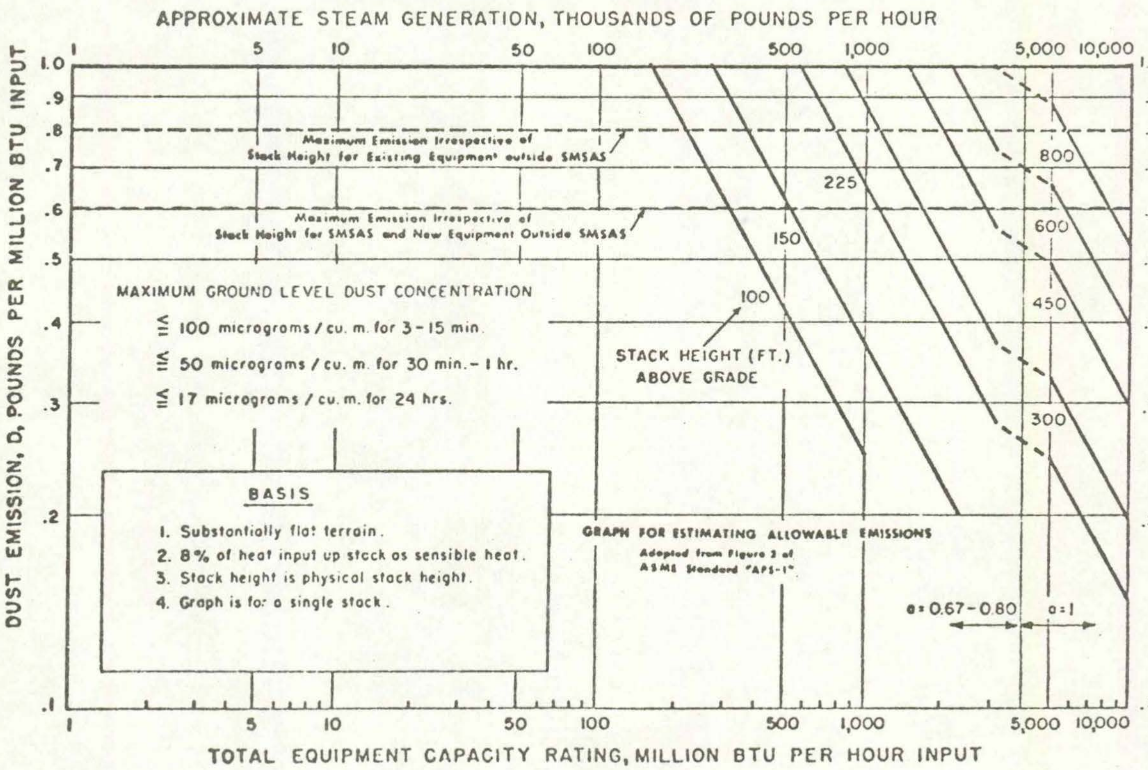
and interpolation and extrapolation of the data for process weight rates in excess of 60,000 lb/hr shall be accomplished by the use of the equation

$$E = 55.0 P^{0.11} - 40,$$

where E = rate of emission in lb/hr, and
P = process weight in tons/hr

FIGURE 1

COMBUSTION FOR INDIRECT HEAT EXCHANGERS



(3) In new equipment, the maximum allowable emissions from each stack, irrespective of height or location, shall be 0.6 pounds of particulates per million BTU input.

(4) Measurements of emissions from a particulate source will be made in accordance with the provisions of chapter 7.

c. Fugitive dust. After September 1, 1972, no person shall allow, cause or permit any materials to be handled, transported or stored; or a building, its appurtenances or a construction haul road to be used, constructed, altered, repaired or demolished, with the exception of farming operations or dust generated by ordinary travel on unpaved roads, without taking reasonable precautions to prevent particulate matter in quantities sufficient to create a nuisance, as defined in section 657.1 of the code, from becoming airborne. All persons, with the above exceptions, shall take reasonable precautions to prevent the discharge of visible emissions of fugitive dusts beyond the lot line of the property on which the emissions originate. Reasonable precautions may include, but not be limited to, the following procedures.

(1) Use, where practical, of water or chemicals for control of dusts in the demolition of existing buildings or structures, construction operations, the grading of roads or the clearing of land.

(2) Application of suitable materials, such as but not limited to asphalt, oil, water or chemicals, on dirt roads, material stockpiles, race tracks and other surfaces which can give rise to airborne dusts.

(3) Installation and use of containment or control equipment, to enclose or otherwise limit the emissions resulting from the handling and transfer of dusty materials, such as but not limited to grain, fertilizer or limestone.

(4) Covering, at all times when in motion, open-bodied vehicles transporting materials likely to give rise to airborne dusts.

(5) Prompt removal of earth or other material from paved streets on to which earth or other material has been transported by trucking or earth-moving equipment, erosion by water or other means.

d. Visible emissions. After September 1, 1972, no person shall allow, cause or permit the emission of visible air contaminants of a density or shade equal to or darker than that designated as Number 2 on the Ringelmann Chart, or 40 percent opacity, into the atmosphere from any fuel-burning equipment, internal combustion engine, premise fire, open fire or stack, except as provided below and in chapter 5 of these rules.

(1) Residential heating equipment. Residential heating equipment serving dwellings of four family units or less is exempt.

(2) Gasoline-powered vehicles. No person shall allow, cause or permit the emission of visible air contaminants from gasoline-powered motor vehicles for longer than five consecutive seconds.

(3) Diesel-powered vehicles. No person shall allow, cause or permit the emission of visible air contaminants from diesel-powered motor vehicles of a shade or density equal to or darker than that designated as Number 2 on the Ringelmann Chart, or 40 percent opacity, for longer than five consecutive seconds.

(4) Diesel-powered locomotives. No person shall allow, cause or permit the emission of visible air contaminants from diesel-powered locomotives of a shade or density equal to or darker than that designated as Number 2 on the Ringelmann Chart, or 40 percent opacity, except for a maximum period of 40 consecutive seconds during acceleration under load, or for a period of four consecutive minutes when a locomotive is loaded after a period of idling.

(5) Startup and testing. Initial start and warmup of a cold engine, the testing of an engine for trouble, diagnosis or repair, or engine research and development activities, is exempt.

(6) Uncombined water. The provisions of this paragraph shall apply to any emission which would be in violation of these provisions except for the presence of uncombined water, such as condensed water vapor.

4.3(3) Sulfur compounds. The provisions of this subrule shall apply to any installation from which sulfur compounds are emitted into the atmosphere.

a. Sulfur dioxide from use of fuels. After January 1, 1975, no person shall allow, cause or permit the emission of sulfur dioxide into the atmosphere in an amount greater than five pounds of sulfur dioxide, maximum two-hour average per million BTUs of heat input per hour from any solid fuel-burning installation for any combination of fuels burned; nor the emission of sulfur dioxide into the atmosphere in an amount greater then 1.5 pounds of sulfur dioxide, maximum two-hour average, per million BTUs of heat input per hour from any liquid fuel-burning installation. An emission reduction program for meeting the emission standards of this paragraph shall be submitted on or before January 1, 1974 by the owner or operator of any solid or liquid fuel-burning source with heat input equal to or greater than 250 million BTUs per hour.

b. Sulfur dioxide from sulfuric acid manufacture. After January 1, 1975 no person shall allow, cause or permit the emission of sulfur dioxide from an existing sulfuric acid manufacturing plant in excess of 30 pounds of sulfur dioxide, maximum two-hour average, per ton of product calculated as 100 percent sulfuric acid.

c. Acid mist from sulfuric acid manufacture. After January 1, 1974, no person shall allow, cause or permit the emission of acid mist calculated as sulfuric acid from an existing sulfuric acid manufacturing plant in excess of 0.5 pounds, maximum two-hour average, per ton of product calculated as 100 percent sulfuric acid.

d. Other processes capable of emitting sulfur dioxide. After January 1, 1974, no person shall allow, cause or permit the emission of sulfur dioxide from any process, other than sulfuric acid manufacture, in excess of 500 parts per million, based on volume. This paragraph shall not apply to devices which have been installed for air pollution abatement purposes where it is demonstrated by the owner of the source that the ambient air quality standards are not being exceeded.

ENVIRONMENTAL PROTECTION AGENCY

[40 CFR Part 60]

[FRL 279-2]

STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

Coal Preparation Plants

Pursuant to section 111 of the Clean Air Act, as amended, the Administrator proposes herein standards of performance for new and modified coal preparation plants.

On December 23, 1971, the first standards of performance were promulgated. Those were for affected facilities at new fossil fuel-fired steam generators, incinerators, portland cement plants, nitric acid plants, and sulfuric acid plants. Since that time, additional standards have been proposed for other categories of sources (March 8, 1974, 39 FR 9308) and several other publications in the FEDERAL REGISTER have amended the standards.

As prescribed by section 111, proposal of standards for coal preparation plants was preceded by the Administrator's determination that these plants contribute significantly to air pollution which causes or contributes to the endangerment of public health or welfare and by his publication of this determination in this issue of the FEDERAL REGISTER.

Coal preparation plants were selected for the development of standards based primarily on the expectation of increased demand for coal and the beneficial impact which would result from the application of best technology for air pollution control. Coal preparation plants were recommended for consideration for standards in the "Report of the Committee on Public Works," U.S. Senate, September 17, 1970, and named as a major source of air pollution in 40 CFR Part 52, "Prevention of Significant Air Quality Deterioration," as proposed in the FEDERAL REGISTER, August 27, 1974 (39 FR 31000). The recent emphasis on coal as the long-term source of fossil fuel energy will lend additional impetus to the growth of the coal industry. This may be particularly true of the lower rank lignite and sub-bituminous coals which have heretofore been uneconomical to exploit.

Coal preparation plants are major sources of particulate matter emissions which can have an adverse effect on health. The bases for the proposed standards include the results of emission measurements by the industry, the Environmental Protection Agency and local agencies; emission data derived from available technical literature; information gathered during visits to pollution control agencies and plants in the United States; and comments and suggestions solicited from experts. The proposed standards reflect the degree of emission limitation achievable through the application of the best system of emission reduction which, taking into account the cost of achieving such reduction, the Administrator has determined to have been adequately demonstrated.

The document "Background Information for Standards of Performance: Coal Preparation Plants" which presents information regarding the factors considered in arriving at the proposed standards, including costs and summaries of test data, is available free of charge from the Emission Standards and Engineering Division, Environmental Protection Agency, Research Triangle Park, North Carolina 27711, attention: Mr. Don R. Goodwin. It is emphasized that the costs are considered reasonable for new and modified sources. It is not implied that the same costs apply to the retrofitting of existing sources. Retrofitting to achieve the proposed emission limitations would in some cases cost much more.

It is important to note that the applicability of the standard is intentionally broad. Although the emission measurement data on which the standard is founded was obtained from coal preparation plants processing bituminous coal, the standard is also applicable for all other types of coal. Furthermore, the definition provided for coal preparation plants does not restrict applicability to plants which process coal directly from a coal mine. There are no known thermal coal dryers other than "mine-mouth," but plants which break, crush, or screen coal are relatively common. (For example, such preparation plants will be constructed at new coal-fired power plants and new coke ovens.) Since there is no basic difference in the mechanical processes of breaking, crushing, and screening coal whether they occur at the mine or at some other location, the applicability of the standard was expanded to encompass those processes regardless of their location. Future coal preparation plants at all such facilities must comply with the proposed opacity standard.

Existing installations which had emission rates from the thermal dryer below that of the proposed standard typically controlled emissions with a venturi scrubber in series with a cyclonic separator (which removed entrained water). The scrubber's operating conditions ranged from 25 to 35 inches of water head-loss. It is anticipated that such equipment will continue to be used.

Breaking, crushing, and screening operations may be conducted on coal which may be wet or dry. Those plants which break, crush, and screen wet coal used lower efficiency (3-5 inches of water head-loss) scrubbers. Plants which similarly process dry coal often use fabric filters. Both can achieve the proposed limitation which prohibits opacities of 20 percent or greater.

The standards will require the operator to provide, as part of the new plant design, suitable means (such as taller stacks or internal straightening vanes) to permit measurement of the emissions by EPA's reference methods. The authority for requiring such modifications stems from section 114(a)(1)(c) of the Clean Air Act.

The standards also require the operator to daily sample and analyze for moisture content the product coal from thermal dryers. This information is an indication of the potential dusting problem associated with conveying, storing, and transfering dried coal. Fine coal dried to low surface moisture levels is generally recognized to have extreme dusting properties. Facilities which dry coal to low moisture levels will have to install adequate control equipment in order to achieve applicable opacity standards. For facilities that have not installed necessary control equipment, but change their operating practices to dry coal to low levels, product coal moisture information can be used as evidence of violation of best operating and maintenance requirements. Facilities which elect to routinely dry coal to low moisture levels may demonstrate during the performance test the effectiveness of their control equipment to show that these operating practices are consistent with applicable emission regulations. These data gathering and recordkeeping requirements do not represent an additional burden for most thermal drying facilities. Such analyses are routinely performed daily as part of the source owner's quality assurance program in order to determine that customer specifications are met and in order to determine the customer's cost per ton (dried coal is often sold on a cents per million Btu basis).

In accordance with section 117(f) of the Act, publication of these proposed amendments to 40 CFR 60 was preceded by consultation with appropriate advisory committees, independent experts, and Federal departments and agencies. The possible adverse environmental impact resulting from the proposed standards has been considered and determined to be negligible as discussed in the background information document. The proper management of solid wastes resulting from air pollution control systems should be practiced. Air pollution control technologies generate many different amounts and types of solid wastes and liquid concentrates through the removal of pollutants from air emissions. These substances vary greatly in their chemical and physical composition. A variety of techniques may be employed to dispose of these substances. When thermal processing is the choice for disposal, provisions must be made to ensure minimal reentry of the pollutants into the atmosphere in accordance with State and local regulations. Consideration should also be given to recovery of materials of value in the wastes. When land disposal is selected, practices similar to proper sanitary landfill technology may be followed. The principles set forth in EPA's Land Disposal of Solid Waste Guidelines (40 CFR Part 241) may be used as guidance for acceptable land disposal techniques.

Coal preparation plants are inherently one of the Nation's major sources of solid waste pollution. This refuse consists of dirt and other contaminants that are mined with the coal and separated from it by the preparation plant. The wet preparation process uses copious quantities of water to accomplish the separation. The additional water requirements and solid waste pollution attributable to control of air pollution are minor when compared to the waste by-products of the basic process.

Based on the expected annual growth in new and modified thermal dryer facilities, the incremental increase in total energy consumption (primarily attributable to fan power requirements for air pollution control equipment) in excess of that required to achieve State standards is projected to be 6 million kilowatt hours per year. This energy requirement is a small fraction of the total power consumed annually by coal preparation plants and contiguous mining operations.

The economic impact of the standard to control thermal dryers above that incurred under existing State standards will be about a 3 percent increase in capital investment and an incremental cost of $0.02 per ton. Neither figure would seriously affect any decision to construct a new coal preparation plant. For air tables, the fabric filter now frequently used to achieve the State standards will also provide compliance with the standard of performance, so the economic impact is minimal.

Standards sometimes result in a more severe economic impact on smaller than on larger firms. This is partially the result of economies of scale that generally favor larger equipment installations. In the case of coal preparations plants, however, a complete new plant requires an investment of about $10 million. Any company large enough to afford the capital outlay would find the additional investment required for Federal air pollution control a very small portion of the total cost.

The proper use of and test methods for opacity standards are presently being reconsidered by the Agency in response to remands from the United States Court of Appeals for the District of Columbia Circuit in Portland Cement Association v. Ruckelshaus, 486 F. 2d 375 (1973), and Essex Chemical Corp. v. Ruckelshaus, 486 F. 2d 427 (1973). The response to the remand in the Portland Cement case should be completed shortly. At that time, the Agency will promulgate or propose such revisions of its opacity standards or test methods as it deems necessary or desirable. In accordance with section 117(f) of the Act, publication of these proposed amendments to 40 CFR was preceded by consultation with appropriate advisory committees, independent experts and Federal departments and agencies. In the course of these consultations, the Department of Commerce has questioned the establishment of visible emissions (opacity) standards. The Department of Commerce believes that opacity limits have not been satisfactorily correlated to give rates of particulate concentration emissions or mass emissions to establish opacity as a standard. Further, Commerce has questioned whether such standards would be subject to accurate visual determination. Commerce, therefore, recommended that opacity limits not be adopted as a standard where a particulate concentration or mass emission standard is established. Commerce believes such opacity limits should only be used in those cases to create a rebuttable presumption of a violation of the particulate or mass emissions standards. Commerce believes such presumption could, for example, be rebutted by providing a continuous opacity monitor record showing a visual opacity observation to be in error; and/or by a showing that the particulate concentration or mass emissions standards was not exceeded at the time the opacity limit was exceeded. Commerce believes such a showing could be made by a performance test. If the owner or operator wished to use such test to show that he was not in violation of the mass or concentration standard at the time the opacity limit was exceeded, he must be able to establish the critical plant and control operating parameters that existed at the time of the observed opacity violation by a system of continuous monitoring and recording of such data so that such conditions can be duplicated at the time of the test.

EPA does not support the approach suggested by the Department of Commerce and is proposing opacity standards in the regulation. EPA believes that the opacity concept is both technically sound and the most practical and inexpensive way to insure that control equipment is adequately maintained and operated between performance tests. A performance test conducted after a source was observed to be in violation of the opacity standard would not in EPA's opinion necessarily resolve the question whether, at the time of the observed violation, the source was meeting the concentration standard. During the period between the observed violation of the opacity standard and the time of the performance test, the owner or operator in some cases could take remedial action to bring a non-complying source into compliance. EPA's opinion is that the only way to resolve this problem would be through use of a continuous monitoring system or through performance tests conducted at such frequent intervals as to yield similar results. EPA believes the approach suggested by the Department of Commerce is not a realistic or practical alternative in the absence of an appropriate continuous monitoring system. However at the request of the Department of Commerce, EPA is submitting for public comment that agency's recommendation and will consider any comments of State officials, industrial representatives, environmentalists, and the general public on this or any other alternative approach.

Interested persons may participate in this rulemaking by submitting written comments (in triplicate) to the Emission Standards and Engineering Division, Environmental Protection Agency, Research Triangle Park, North Carolina 27711, attention: Mr. Don R. Goodwin. The Administrator will welcome comments on all aspects of the proposed regulations, including economic and technological issues. All comments received on or before December 9, 1974, will be considered. Comments received will be available for public inspection at the Office of Public Affairs, 401 M Street, SW., Washington, D.C. 20460.

(Secs. 111 and 114 of the Clean Air Act, as amended (42 U.S.C. 1857c-6 and 9))

Dated: October 11, 1974.

JOHN QUARLES,
Acting Administrator.

It is proposed to amend Part 60 of Chapter I, Title 40 of the Code of Federal Regulations by adding new subpart Y as follows:

Subpart Y—Standards of Performance for Coal Preparation Plants

Subpart Y—Standards of Performance for Coal Preparation Plants

§ 60.250 Applicability and designation of affected facility.

The provisions of this subpart are applicable to the following affected facilities in coal preparation plants: thermal dryers; pneumatic coal-cleaning equipment (air tables); coal processing and conveying equipment (including breakers and crushers); screening (classifying) equipment; coal storage and coal transfer points; and coal loading facilities.

§ 60.251 Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Act and in subpart A of this part.

(a) "Coal preparation plant" means a facility which prepares coal by any or all of the following processes: breaking, crushing, screening, cleaning (both wet and dry methods), and drying.

(b) "Coal" means anthracite, bituminous, subbituminous, lignite, or any other solid fossil fuel normally considered coal as classified by A.S.T.M. Designation D-388-66.

(c) "Cyclonic flow" means a spiraling movement of exhaust gases within a duct or stack.

(d) "Thermal dryer" means any facility in which the moisture content of coal is reduced by contact with a heated gas stream.

(e) "Pneumatic coal-cleaning equipment" means any facility which classifies coal by size or separates coal from refuse by application of air stream(s) to the coal.

(f) "Coal processing and conveying equipment" means any machinery used to reduce the size of coal or to separate coal from refuse, and the equipment used to convey coal to or remove coal and refuse from the machinery. This includes, but is not limited to, breakers, crushers, screens, and conveyor belts.

(g) "Coal storage system" means any facility used to store coal which is either unprocessed ("run-of-the-mine") or processed (classified or dried).

(h) "Transfer and loading system" means any facility used to load processed coal for shipment.

(i) "Surface moisture" is defined as the difference between total moisture as determined by ASTM D271-71 and equilibrium moisture by ASTM D1412-61 (1968).

§ 60.252 Standard for particulate matter.

(a) On and after the date on which the performance test required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from any thermal dryer gases which:

(1) Contain particulate matter in excess of 0.070 g/dscm (0.031 gr/dscf).

(2) Exhibit 30 percent opacity or greater.

(b) On and after the date on which the performance test required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from any pneumatic coal cleaning equipment gases which:

(1) Contain particulate matter in excess of 0.040 g/dscm (0.018 gr/dscf).

(2) Exhibit 20 percent opacity or greater.

(c) On and after the date on which the performance test required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from any coal processing and conveying equipment, coal storage systems, or coal transfer and loading systems gases which exhibit 20 percent opacity or greater.

§ 60.253 Monitoring of operations.

(a) Continuous monitoring systems shall be installed, calibrated, maintained, and operated by the source owner or opeator of any thermal dryer as follows:

(1) A continuous monitoring system for the measurement of the pressure loss through the control device of the gas stream on a continuous basis.

(2) A continuous monitoring system for the measurement of the temperature of the gas stream at the exit of the thermal dryer on a continuous basis.

(b) The source owner or operator shall sample, analyze, and record daily, the surface moisture content of product coal from the thermal dryer. The sample shall be selected, prepared, and analyzed in accordance with ASTM procedures D2234-72 for mechanical sampling, D2013-72 for sample preparation, and D271-70 for sample analysis.

§ 60.254 Test methods and procedures.

(a) The reference methods in Appendix A of this part, except as provided in § 60.8(b), shall be used to determine compliance with the standards prescribed in § 60.252 as follows:

(1) Method 5 for the concentration of particulate matter and associated moisture content,

(2) Method 1 for sample and velocity traverses,

(3) Method 2 for velocity and volumetric flow rate, and

(4) Method 3 for gas analysis.

(b) For Method 5, the sampling time for each run shall be at least 60 minutes and the minimum sample volume shall be 0.85 dscm (30 dscf) except that shorter sampling times or smaller volumes, when necessitated by process variables or other factors, may be approved by the Administrator. Sampling shall not start until 30 minutes after startup and shall terminate before shutdown procedures commence. The owner or operator of the affected facility shall eliminate cyclonic flow during performance tests in a manner acceptable to the Administrator.

(c) For the purpose of this subpart, § 60.12 does not prohibit addition of diluent gases to the inlet of any particulate matter control device.

(d) The air pollution control system for thermal dryers or pneumatic coal-cleaning equipment shall be constructed so that particulate emissions can be accurately determined by applicable test methods and procedures.

[FR Doc.74-24356 Filed 10-23-74;8:45 am]

APPENDIX B

Report To

Governor Robert D. Ray

On The Coordination of Air Pollution Control

Regulations and Iowa Coal Usage

REPORT TO
GOVERNOR ROBERT D. RAY
ON THE COORDINATION OF AIR POLLUTION CONTROL
REGULATIONS AND IOWA COAL USAGE

Presented by

The Iowa Department of Environmental Quality
(Air Quality Management Division and the Air Quality Commission)

October 22, 1975

TABLE OF CONTENTS

Introduction

The Clean Air Act of 1970 launched states on a journey to purify the atmosphere to the point of insuring public health. Specific standards were set federally to be met in all places in the United States where persons may reasonably be expected to breathe. In order to meet these standards, regulations were developed by states to limit the emissions of various pollutants at their sources. These regulations were developed using techniques made available by the U. S. Environmental Protection Agency (EPA) to the then novice state air pollution control agencies. In general, these techniques were crude and were made to apply to vast areas based on sparse information from remote locations. The limitations placed on Iowa companies for sulfur dioxide were based on the best available information in 1970. This information consisted primarily of sulfur dioxide pollution levels in Peoria, Illinois.

Although the Peoria data might not have been representative of Iowa's air quality, it was sufficient to define levels of control in Iowa which would guarantee the eventual attainment of health-related standards for sulfur dioxide. The regulations subsequently developed would have posed no significant economic burden upon Iowa facilities provided that the availability and prices of oil and low sulfur coal would not change appreciably. The "energy crisis" of succeeding years has proved that this assumption was false.

In June, 1974, Congress passed the Energy Supply and Environmental Coordination Act (ESECA), the purpose of which was to identify areas in the country where pollution control regulations were overly restrictive and to encourage the utilization of coal where health-related air pollution standards would not be jeopardized. Today the EPA, the Federal Energy Administration, and other states are pursuing methods for accomplishing the goals of ESECA. Also today the Department of Environmental Quality (DEQ) is happy to report that Iowa may be the first state to succeed in finding a comprehensive approach to its energy-air pollution dilemma.

Even before Congress had finished discussing the need for coordinating energy supplies and air pollution control in general terms, Iowa's executive branch and the legislature were cooperatively discussing what could be done for Iowa in specific terms. The problems with the lack of pertinent information were defined, DEQ developed a plan, and the legislature appropriated $133,000 for a research project to collect the necessary data. Since coal is Iowa's only native energy resource, special emphasis was given to finding a means of maximizing the usage of Iowa coal while minimizing the danger to public health from such usage.

Project Description

Data werecollected from November, 1974, through January 1975, around the Iowa State University Power Plant and from February through April, 1975, around the Iowa Power and Light Company generating station near Des Moines. The study was very intensive and provided information on coal, ash, stack gases, meteorology, and continuous air contaminant data at eight locations predicted to be at or near the vicinity of maximum sulfur dioxide concentration. The methods used represent the state of the art in air pollution measurement.

For the past several months, the data have been analyzed by DEQ experts through sophisticated computer techniques. Computer models have been applied to all other major coal users in the state and the results of the data acquisition have been used to calibrate these applications to reflect as best as possible the real situations around these coal users. Conservative judgments have been made in conjunction with statistical techniques and a percent sulfur in coal allowable has been developed on a case-by-case basis.

Analysis Parameters

In order to arrive at meaningful conclusions concerning Iowa coal usage, various situations were postulated and their ramifications explored. Iowa coal was assumed to have a sulfur content of 6%. In order to maximize Iowa coal usage, the relative amounts of Iowa coal mixed with 3% sulfur Illinois coal or 0.5% sulfur Wyoming coal were calculated. The amounts of Iowa coal allowable were then determined based on current coal usage at each installation and also based on total fuel requirements. It is important to consider the total fuel requirements since only about two years remain for most electrical generation using natural gas. At that time, natural gas burning will have to be replaced by coal burning. In order to explore future possibilities, the success of the Iowa Coal Research Project in reducing the sulfur content of Iowa coal to 3.5% was also assumed and the above described analysis duplicated.

Each coal burning installation was analyzed on the merits of its actual situation. Included for consideration were the present air quality at the location of the plant and the factors which have a direct influence on that air quality. These factors include the height of smokestacks, the amounts of fuel required, velocity and temperature of gases in the stacks, influence of neighboring air pollution sources, local meteorology, and other items.

Results

Current air pollution control regulations on sulfur dioxide for existing installations effectively limit coal to a 3% sulfur content. This limitation is uniformly applied to all coal burning facilities in Iowa. The results of the research study indicate that when a case-by-case analysis is done, the allowable percent sulfur for various installations ranges from 0.52% to greater than 6%. This means that at a few locations in the state, a regulation more restrictive than the one which presently applies may be warranted, but a less restrictive regulation could be applicable in the majority of cases.

The Appendix lists the coal burning plants with the appropriate results. As a summary, the following results apply to the state as a whole:

Amount of Iowa Coal Allowable In Tons Per Year	Based On
1,396,190	6% S* Iowa coal mixed with 3% S Illinois coal at the present rate of coal consumptic
2,281,037	6% S Iowa coal mixed with 3% S Illinois coal at present heat requirements.
3,015,577	6% S Iowa coal mixed with 0.5% S Wyoming co at the present rate of coal consumption.
3,738,740	3.5% S Iowa coal mixed with 3% S Illinois coal at the present rate of coal consumptio
4,717,766	6% S Iowa coal mixed with 0.5% S Wyoming coal at present heat requirement.
4,730,647	3.5% S Iowa coal mixed with 0.5% Wyoming coal at the present rate of coal consumptio
5,951,282	3.5% S Iowa coal mixed with 3% S Illinois coal at present heat requirement.
7,331,557	3.5% S Iowa coal mixed with 0.5% S Wyoming coal at present heat requirement.

*S = Sulfur

In 1974, Iowa utilized about 600,000 tons of its native coal. The research indicates, therefore, that Iowa could utilize between 230% and 1200% of current Iowa coal consumption and still be consistent with meeting health-related air pollution standards. The situation appears to be optimistic, especially if the Iowa Coal Research Project is successful. It should be noted that if this is the case, beneficiated Iowa coal could be substituted for the Illinois coal used to typify a three percent sulfur coal. Even if the coal mining project fails, an increase of nearly 700% in Iowa coal consumption could be allowed.

Furthermore, the most restrictive cases of allowable sulfur content such as applying to John Deere, Waterloo, may be somewhat ameliorated through discussions with DEQ engineers about possible engineering modifications which could lead to a less restrictive sulfur control standard.

In four Iowa cities, the proximity of large coal users compounds the air pollution situation so that the percent sulfur allowable is significantly less than would otherwise be possible. These cities are Clinton, Dubuque, Muscatine, and Waterloo. The percent sulfur allowable listed in the Appendix for all plants affected by the proximity of other sulfur dioxide sources, in each of these four cities is identical to provide equitable application of enforcement. However, if for any reason one firm was able to utilize a lower sulfur fuel than that suggested, it would be possible to apply a less restrictive regulation to the other affected plants in the same city. DEQ will request conferences with the plants in the above cities to discuss this situation and try to arrive at the best overall solution for the public's benefit.

A full technical report on the entire project is being prepared for interested parties and should be available in the near future.

Cautions

Although the results of the research contained herein indicate due optimism, it is important to also surface some appropriate cautions.

(1) These results apply to existing plants, which only have an average maximum lifetime of about 25 years. Any new large power plants would have to meet the currently effective state and federal standards which are much more restrictive for new power plants. This measure will help insure that growth will not be the cause for exceeding health-related standards in the future.

(2) Some installations may not have equipment which could burn Iowa coal because of ash or slag problems. It is not anticipated that this will be a significant obstacle to overall Iowa coal usage, however.

(3) To effect changes in restrictions, the Iowa Air Quality Commission will have to make amendments to DEQ departmental rules. This will involve public hearings and eventual submission to the EPA for approval as a formal amendment to Iowa's plan for controlling air pollution. Although EPA approval is not guaranteed, DEQ feels that it stands on solid technical grounds and that it has followed the spirit and letter of applicable laws passed by Congress to promote actions such as Iowa has taken.

(4) The state-of-the-art of air pollution predicting has not yet developed to the point of adequately considering topographic anomalies. Therefore, the situation in river valleys may be somewhat different than projected. However, years may elapse before this situation is fully understood.

(5) Future air monitoring may indicate the development of problems not yet foreseen, in which case a more restrictive approach would need to be taken for that specific location.

(6) Although EPA has no standards for atmospheric sulfates (sulfates are substances formed by the chemical reaction of sulfur dioxide with other materials) it has expressed concern over increased midwest emissions causing problems in New England. For this reason the largest power plants whose emissions travel farthest are proposed to be limited to 4% sulfur coal even though a less restrictive approach may have been possible. This approach should assure our eastern neighbors that we are concerned about their possible problem even if conclusive evidence is not yet available. Another reason for taking a more conservative approach with these plants is because slight errors in making projections concerning them could be significantly amplified by their great coal burning volume.

(7) The coal consumption and total heat requirement data used in this report are based on 1974 data, and may not reflect the current situation in every coal burning installation being considered.

Actions To Be Taken

The results of this study will be presented to the Air Quality Commission at its November 12, 1975 meeting. Suggested changes in departmental rules will also be presented so that hearings can be held expeditiously. In essence, those suggestions will contain the following:

Rescind the present 6 lb. per million BTU* heat input limitation on sulfur dioxide emissions from coal burning installations (an effective 3% sulfur limitation) and replace it with an effective allowable 6% sulfur coal for power plants with a coal burning heat input capacity of 500 million BTUs/hr. or less, 4% sulfur coal for power plants with a coal burning heat input capacity of 1,500 million BTUs/hr. or larger, and a specific limitation as taken from the chart in the Appendix for all facilities in the intermediate range. Exceptions may be made for the installations in Clinton, Dubuque, Muscatine, and Waterloo. For these installations, the limitations recommended for public hearing will be those listed in the Appendix - however, conferences held in the interim may make the limitations on some of those plants less restrictive before final actions are taken.

*DEQ is prevented by the Code of Iowa from specifying fuels. Therefore, sulfur limitations must be applied indirectly through regulating stack emissions.

Acknowledgements

The success of the project described in this report was made possible through the coordination and cooperation of many agencies and organizations. The legislative appropriation covered only a fraction of the total cost of this research and therefore special recognition is in order for the assistance given to DEQ in gathering and providing information. These groups are the State Hygienic Laboratory at the University of Iowa; the Departments of Climatology and Meteorology, Electrical Engineering, and Physical Plant at Iowa State University; the Iowa Coal Research Project; Iowa Power and Light Company; the Energy Policy Council; the Iowa State Commerce Commission; the Iowa Geological Survey; the Des Moines-Polk County Health Department; and the University of Wisconsin.

% S Iowa Coal
: S Ill. Coal
0.5% S Wyoming Coal

Plant	%s Allowable	% Ia./% Wyo. Coal Allowable	% Ia./% Ill. Coal Allowable	Total Amount of Coal Consumed (TPY)	Coal Equivalent of Total BTU Consumed (TPY)	With Wyo. Mixture Amounts of Iowa Coal Allowed (TPY) Based On		With Ill. Mixture Amounts of Iowa Coal Allowed (TPY) Based On	
						Coal Consumed	Total BTUs required	Coal Consumed	Total BTUs Required
es Municipal	2.89	43.5/56.5	0/0	45,359	126,455	19,731	55,008	0	0
dar Falls Utilities	5.55	91.8/8.2	85.0/15.0	50,037	110,743	45,934	101,662	42,531	94,132
lotex, Dubuque	1.85	24.6/75.6	0/0	5,200	14,450	1,276	3,547	0	0
inton Corn	2.22	31.3/68.7	0/0	245,300	245,300	76,712	76,712	0	0
rn Belt Power - Spencer	6.0	100/0	100/0	44,870	110,380	44,870	110,380	44,870	110,380
Pont, Clinton	2.22	31.3/68.7	0/0	114,007	114,427	35,653	35,784	0	0
stern Iowa - Montpelier	3.87	61.3/38.7	29.0/71.0	74,500	142,631	45,669	87,433	21,605	41,363
ain Processing	1.51	18.4/81.6	0/0	5,290	218,840	971	40,187	0	0
binger, Keokuk	4.03	64.2/35.8	34.3/65.7	65,756	65,756	42,203	42,203	22,576	22,576
terstate Power - Dubuque	1.85	24.6/75.6	0/0	124,605	264,400	30,585	64,898	0	0
terstate Power - Lansing Sta.	3.55	55.5/44.5	18.3/81.7	143,906	161,526	79,868	89,647	26,335	29,559
a Army Ammunition	6.0	100/0	100/0	24,375	24,669	24,375	24,669	24,375	24,669
a Electric - Boone	3.71	58.4/41.6	23.7/76.3	16,282	90,500	9,509	52,852	3,859	21,449
a Electric - Iowa Falls	6.0	100/0	100/0	2,458	18,648	2,458	18,648	2,458	18,648
Power - Council Bluffs	3.06	46.5/53.5	2.0/98.0	281,646	443,880	130,965	206,400	5,633	0
- Carroll Station	6.0	100/0	100/0	2,361	10,995	2,361	10,995	2,361	10,995
- Eagle Grove	6.0	100/0	100/0	947	8,176	947	8,176	947	8,176

61, p=0.95

3.5% S Iowa Coal
3.0% S Illinois Coal
0.5% S Wyoming Coal

ower Plant	%s Allowable	% Ia./% Wyo. Coal Allowable	% Ia./% Ill. Coal Allowable	Total Amount of Coal Consumed (TPY)	Coal Equivalent of Total BTU Consumed (TPY)	With Wyo. Mixture Amounts of Iowa Coal Allowed (TPY) Based On: Coal Consumed	With Wyo. Mixture: Total BTUs required	With Ill. Mixture Amounts of Iowa Coal Allowed (TPY) Based On: Coal Consumed	With Ill. Mixture: Total BTUs Required
es Municipal	2.89	79.7/20.3	0/0	45,359	126,455	36,151	100,785	0	0
edar Falls Utilities	5.55	100/0	100/0	50,037	110,743	50,037	110,743	50,037	110,743
elotex, Dubuque	1.85	45.0/55.0	0/0	5,200	14,450	2,340	6,503	0	0
linton Corn	2.22	57.3/42.7	0/0	245,300	245,300	140,639	140,639	0	0
orn Belt Power - Spencer	6.0	100/0	100/0	44,870	110,380	44,870	110,380	44,870	110,380
uPont, Clinton	2.22	57.3/42.7	0/0	114,007	114,427	65,364	65,605	0	0
astern Iowa - Montpelier	3.87	100/0	100/0	74,500	142,631	74,500	142,631	74,500	142,631
ain Processing	1.51	33.7/66.3	0/0	5,290	218,840	1,781	73,676	0	0
inger, Keokuk	4.03	100/0	100/0	65,756	65,756	65,756	65,756	65,756	65,756
terstate Power - Dubuque	1.85	45.0/55.0	0/0	124,605	264,400	56,072	118,980	0	0
terstate Power - Lansing Sta.	3.55	100/0	100/0	143,906	161,526	143,906	161,526	143,906	161,526
a Army Ammunition	6.0	100/0	100/0	24,375	24,669	24,375	24,669	24,375	24,669
a Electric - Boone	3.71	100/0	100/0	16,282	90,500	16,282	90,500	16,282	90,500
a Electric - Iowa Falls	6.0	100/0	100/0	2,458	18,648	2,458	18,648	2,458	18,648
Power - Council Bluffs	3.06	85.3/14.7	12.0/88.0	281,646	443,880	240,244	378,630	33,798	53,270
- Carroll Station	6.0	100/0	100/0	2,361	10,995	2,361	10,995	2,361	10,995
- Eagle Grove	6.0	100/0	100/0	947	8,176	947	8,176	947	8,176

n=61, p=0.95

.e 2

6% S Iowa Coal
3% S Illinois Coal
0.5% S Wyoming Coal

[illegible]	%s Allowable	% Ia./% Wyo. Coal Allowable	% Ia./% Ill. Coal Allowable	Total Amount of Coal Consumed (TPY)	Coal Equivalent of Total BTU Consumed (TPY)	With Wyo. Mixture Amounts of Iowa Coal Allowed (TPY) Based On		With Ill. Mixture Amounts of Iowa Coal Allowed (TPY) Based On	
						Coal Consumed	Total BTUs required	Coal Consumed	Total BTUs Required
[illegible] - Maynard	0.52	0.4/99.6	0/0	66,730	226,800	243	825	0	0
S - Storm Lake	6.0	100/0	100/0	3,080	21,589	3,080	21,589	3,080	21,589
a Southern - Bridgeport Sta.	2.8	41.8/58.2	0/0	146,484	147,600	61,230	61,697	0	0
S.U. - Ames	3.26	50.2/49.8	8.7/91.3	95,293	95,293	47,837	47,837	8,290	8,290
n Deere, Dubuque	5.96	99.3/0.7	98.7/1.3	35,208	116,408	34,952	115,561	34,739	114,856
n Deere, Ottumwa	6.0	100/0	100/0	5,746	5,746	5,746	5,746	5,746	5,746
n Deere, Waterloo	0.52	0.4/99.6	0/0	72,794	72,794	265	265	0	0
[illegible] - Hayes	6.0	100/0	100/0	5,600	5,600	5,600	5,600	5,600	5,600
atine Municipal	1.51	18.4/81.6	0/0	204,949	253,157	37,636	46,489	0	0
Mayer, Davenport	6.0	100/0	100/0	31,392	66,127	31,392	66,127	31,392	66,127
la Municipal	5.19	85.3/14.7	73.0/27.0	75,337	75,585	64,262	64,474	54,996	55,177
ston Purina, Davenport	6.0	100/0	100/0	10,519	10,519	10,519	10,519	10,519	10,519
h Packing, Waterloo	6.0	100/0	100/0	35,547	76,947	35,547	76,947	35,547	76,947
ncer Municipal	6.0	100/0	100/0	500	1,500	500	1,500	500	1,500
versity of Iowa	6.0	100/0	100/0	41,874	52,074	41,874	52,074	41,874	52,074
ster City Municipal	6.0	100/0	100/0	5,841	6,391	5,841	6,391	5,841	6,391
son Company, Cedar Rapids	5.06	82.9/17.1	68.7/31.3	31,700	40,950	26,282	33,951	21,767	28,119

-61, p=0.95

:e 2 3.5% S Iowa Coal
3.0% S Illinois Coal
0.5% S Wyoming Coal

..r Plant	%s Allowable	% Ia./% Wyo. Coal Allowable	% Ia./% Ill. Coal Allowable	Total Amount of Coal Consumed (TPY)	Coal Equivalent of Total BTU Consumed (TPY)	With Wyo. Mixture Amounts of Iowa Coal Allowed (TPY) Based On: Coal Consumed	With Wyo. Mixture: Total BTUs required	With Ill. Mixture Amounts of Iowa Coal Allowed (TPY) Based On: Coal Consumed	With Ill. Mixture: Total BTUs Required
- Maynard	0.52	0.7/99.3	0/0	66,730	226,800	445	1,512	0	0
- Storm Lake	6.0	100/0	100/0	3,080	21,589	3,080	21,589	3,080	21,589
a Southern - Bridgeport Sta.	2.8	76.7/23.3	0/0	146,484	147,600	112,353	113,209	0	0
.U. - Ames	3.26	92.0/8.0	52.0/48.0	95,293	95,293	87,670	87,670	49,552	49,552
n Deere, Dubuque	5.96	100/0	100/0	35,208	116,408	35,208	116,408	35,208	116,408
n Deere, Ottumwa	6.0	100/0	100/0	5,746	5,746	5,746	5,746	5,746	5,746
n Deere, Waterloo	0.52	0.7/99.3	0/0	72,794	72,794	485	485	0	0
sey - Hayes	6.0	100/0	100/0	5,600	5,600	5,600	5,600	5,600	5,600
catine Municipal	1.51	33.7/66.3	0/0	204,949	253,157	68,999	85,230	0	0
.r Mayer, Davenport	6.0	100/0	100/0	31,392	66,127	31,392	66,127	31,392	66,127
la Municipal	5.19	100/0	100/0	75,337	75,585	75,337	75,585	75,337	75,585
ston Purina, Davenport	6.0	100/0	100/0	10,519	10,519	10,519	10,519	10,519	10,519
Packing, Waterloo	6.0	100/0	100/0	35,547	76,947	25,547	76,947	35,547	76,947
ncer Municipal	6.0	100/0	100/0	500	1,500	500	1,500	500	1,500
versity of Iowa	6.0	100/0	100/0	41,874	52,074	41,874	52,074	41,847	52,074
ter City Municipal	6.0	100/0	100/0	5,841	6,391	5,841	6,391	5,841	6,391
on Company, Cedar Rapids	5.06	100/0	100/0	31,700	40,950	31,700	40,950	31,700	40,950

=61, p=0.95

age 3 6% S Iowa Coal
3% S Illinois Coal
0.5% S Wyoming Coal

Plant	%s Allowable	% Ia./% Wyo. Coal Allowable	% Ia./% Ill. Coal Allowable	Total Amount of Coal Consumed (TPY)	Coal Equivalent of Total BTU Consumed (TPY)	With Wyo. Mixture Amounts of Iowa Coal Allowed (TPY) Based On: Coal Consumed	With Wyo. Mixture: Total BTU's Required	With Ill. Mixture Amounts of Iowa Coal Allowed (TPY) Based On: Coal Consumed	With Ill. Mixture: Total BTUs Required
erstate Power - Kapp Sta.	2.22	31.3/68.7	0/0	475,664	541,000	148,753	169,185	0	0
Electric - Prairie C. Sta	4.0	64.0/36.0	33.3/67.7	369,090	489,000	236,218	313,280	122,907	163,004
Electric - 6th St. Sta	4.0	64.0/36.0	33.3/67.7	150,605	197,500	96,387	126,400	50,151	65,768
Electric - Sutherland Sta	4.0	64.0/36.0	33.3/67.7	170,451	570,400	109,089	365,056	56,760	189,943
-Illinois - Riverside Sta	4.0	64.0/36.0	33.3/67.7	411,473	752,400	263,343	481,536	137,021	250,549
Power - Des Moines	3.66	57.0/43.0	22.0/78.0	378,641	831,600	215,825	474,012	83,301	182,952
- Port Neal Station	4.0	64.0/36.0	33.3/67.7	1,007,404	1,321,600	644,739	845,824	335,466	440,093
Southern - Burlington	4.0	64.0/36.0	33.3/67.7	459,890	462,000	294,330	295,680	153,143	153,846
TOTALS				5,538,711	8,612,356	3,015,577	4,717,766	1,396,190	2,281,037
PERCENT OF TOTAL COAL CONSUMED OR OF TOTAL HEAT REQUIRED						(54.4%)	(54.8%)	(25.2%)	(26.5%)

365, p=0.999

3.5% S Iowa Coal
3.0% S Ill. Coal
0.5% S Wyoming Coal
(Page 3)

Power Plant	%s Allowable	% Ia./% Wyo. Coal Allowable	% Ia./% Ill. Coal Allowable	Total Amount of Coal Consumed (TPY)	Coal Equivalent of Total BTU Consumed (TPY)	With Wyo. Mixture Amounts of Iowa Coal Allowed (TPY) Based On		With Ill. Mixture Amounts of Iowa Coal Allowed (TPY) Based On	
						Coal Consumed	Total BTUs Required	Coal Consumed	Total BTUs Required
Interstate Power - Kapp Sta.	2.22	57.3/42.7	0/0	475,664	541,000	272,714	310,173	0	0
IA. Electric - Prairie G. Sta	4.0	100/0	100/0	369,090	489,500	369,090	489,500	369,090	489,500
IA. Electric - 6th St. Sta	4.0	100/0	100/0	150,605	197,500	150,605	197,500	150,605	197,500
IA. Electric - Sutherland Sta	4.0	100/0	100/0	170,451	570,400	170,451	570,400	170,451	570,400
Iowa-Illinois - Riverside Sta	4.0	100/0	100/0	411,473	752,400	411,473	752,400	411,473	752,400
Iowa Power - Des Moines	3.66	100/0	100/0	378,641	831,600	378,641	831,600	378,641	831,600
IPS - Port Neal Station	4.0	100/0	100/0	1,007,404	1,321,600	1,007,404	1,321,600	1,007,404	1,321,600
Iowa Southern - Burlington	4.0	100/0	100/0	459,890	462,000	459,890	462,000	459,890	462,000
			TOTALS	5,538,711	8,612,356	4,730,647	7,331,557	3,738,713	5,951,282
PERCENT OF TOTAL COAL CONSUMED OR OF TOTAL HEAT REQUIRED						(85.4%)	(85.1%)	(67.5%)	(69.1%)

n=365, p=0.999

APPENDIX C

Iowa Water Quality Standards

TITLE II

WATER QUALITY

CHAPTER 16

WATER QUALITY STANDARDS

400—16.1(455B) Definitions.

16.1(1) *"Fecal coliform"* means the portion of the coliform group which is present in the gut or the feces of warm-blooded animals. It includes organisms which are capable of producing gas from lactose broth in a suitable culture medium within twenty-four hours at 44.5° + 0.5C.

16.1(2) *"Industrial wastes"* means any solid, liquid or gaseous wastes resulting from any process, or from excess energy, of industry, manufacturing, trade or business or from the development, processing or recovery, except for agricultural crop raising, of any natural resources.

16.1(3) *"Milligrams per liter (mg/l)"* means milligrams of solute per liter of solution-equivalent to parts per million-assuming unit density.

16.1(4) *"Primary contact"* means any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing.

16.1(5) *"Schedule of compliance"* means a schedule of measures including a sequence of actions or operations leading to compliance with an effluent limitation, prohibition, standard or order of the executive director.

16.1(6) *"Secondary contact"* means any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating and any limited contact incident to shoreline activity.

16.1(7) *"Sewage"* means water-carried human and related wastes from any source.

16.1(8) *"Temperature"* means a measure of heat content of water.

400—16.2(455B) General considerations.

16.2(1) *Policy statement.* It shall be the policy of the water quality commission to protect and enhance the quality of all the waters of the state. In the furtherance of this policy it will attempt to prevent and abate the pollution of all waters to the fullest extent possible consistent with statutory, and technological limitations. This policy shall apply to all point and nonpoint sources of pollution.

These water quality standards establish criteria for certain present and future designated uses of the surface waters of the state. The standards establish the areas where these uses are to be protected and provide criteria for waterways having nondesignated uses as well. Many surface waters are designated for more than one use. In these cases the more stringent criteria shall govern for each parameter.

All methods of sample collection, preservation, and analysis used in applying any of the rules in these standards shall be in accord with those prescribed in *"Standard Methods for Examination of Water and Wastewater"*, Thirteenth Edition.

16.2(2) *Nondegradation statement.* Water whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at high quality unless it has been affirmatively demonstrated to the commission that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of such waters. Any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters will be required to provide the degree of waste treatment or controls necessary to maintain high water quality. In implementing this policy, the appropriate agency of the federal government will be kept advised and will be provided with such information as it will need to discharge its responsibilities.

16.2(3) *Minimum treatment required.* All wastes discharged to the waters of the state must be of such quality that the discharge will not cause a violation of the water quality standards of the state. Where the receiving waters provided sufficient assimilative capacity that the water quality standards are not the limiting factor, all wastes shall receive treatment in compliance with minimum effluent standards required by the water quality commission.

16.2(4) *Mixing zone in the receiving water.* The area of diffusion of an effluent in the receiving water is a mixing zone and the water quality standards shall be applied beyond the mixing zone.

The mixing zone shall be a specified linear distance, volume, or area which is determined on a case-by-case basis using the following criteria:

a. The mixing zone shall be as small as practicable and shall not be of such size or shape as to cause or contribute to the impairment of water uses.

b. The mixing zone shall contain not more than 25 percent of the cross sectional area or volume of flow in the receiving body of water.

c. The mixing zone shall be designed to allow an adequate passageway at all times for the movement or drift of aquatic life.

d. Where there are two or more mixing zones in close proximity, they shall be so defined that a continuous passageway for aquatic life is available.

e. The mixing zone shall not intersect any area of any waters in such a manner that the maintenance of aquatic life in the body of water as a whole would be adversely affected.

In determining the size and location of the mixing zone for any discharge on a case-by-case basis, the following shall be considered:

f. The size of the receiving water, the volume of discharge, the stream bank configuration, the mixing velocities, and other hydrologic or physiographic characteristics.

g. The present and anticipated future use of the body of water.

h. The present and anticipated future water quality of the body of water.

i. The ratio of the volume of waste being discharged to the seven-day, ten-year low flow of the receiving stream.

16.2(5) *Implementation strategy.* These water quality standards shall be met at all times when the flow of the receiving stream equals or exceeds the seven-day, ten-year low flow. Exceptions may be made for intermittent or low flow streams. Where intermittent streams are classified for aquatic life protection the commission may waive the seven-day, ten-year low flow requirement and establish a minimum flow in lieu thereof. Such waiver shall be granted by the commission only when it has determined that the aquatic resources of the receiving waters are of no significance at flows less than the established minimum.

400—16.3(455B) Surface water quality criteria.

16.3(1) *General water quality criteria.* The following criteria are applicable to all surface waters including those which have been designated as class "A", "B", or "C" waters, at all places and at all times.

a. Such waters shall be free from substances attributable to municipal, industrial or other discharges or agricultural practices that will settle to form objectionable sludge deposits.

b. Such waters shall be free from floating debris, oil, grease, scum and other floating materials attributable to municipal, industrial or other discharges or agricultural practices in amounts sufficient to be unsightly or deleterious.

c. Such waters shall be free from materials attributable to municipal, industrial or other discharges or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance.

d. Such waters shall be free from substances attributable to municipal, industrial or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

e. The turbidity of the receiving water shall not be increased by more than 25 Jackson turbidity units by any point source discharge.

16.3(2) *Class "A" waters.* Waters which are designated as class "A" waters are to be protected for primary contact recreation. The following criteria shall apply to all class "A" waters:

a. From April 1 through October 31 the discharge of any effluent which may contain human pathogens shall not increase the fecal coliforms in the receiving waters by more than 200 per 100 ml.

b. The pH shall not be less than 6.5 nor greater than 9.0. The maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units.

c. Taste and odor producing substances shall not be present in amounts that will interfere with primary contact recreation.

16.3(3) *Class "B" waters.* Waters which are designated as Class "B" waters are to be protected for wildlife, fish, aquatic and semiaquatic life and secondary contact recreation. The following criteria shall apply to all Class "B" waters:

a. Dissolved oxygen.

(1) The dissolved oxygen shall not be less than 5.0 mg/1 during at least 16 hours of any 24-hour period and not less than 4.0 mg/1 at any time during the 24-hour period.

(2) In areas designated as cold water fisheries the dissolved oxygen shall not be less than 7.0 mg/1 during at least 16 hours of any 24-hour period and not less than 5.0 mg/1 at any time during the 24-hour period.

b. Chemical constituents. The following levels shall not be exceeded at any time the flow equals or exceeds the seven-day, ten-year low flow unless the material is from uncontrollable nonpoint sources:

Ammonia Nitrogen (N)	2.0	mg/l
Phenols (from other than natural sources)	0.001	mg/l
Arsenic	1.0	mg
*Barium	1.0	mg
*Cadmium	0.05	mg
*Chromium (Hexavalent)	0.05	mg/l
*Chromium (Trivalent)	1.0	mg/l
*Copper	0.02	mg/l
Cyanide	0.025	mg/l
*Lead	0.10	mg/l
*Zinc	1.0	mg/l
*Selenium	1.0	mg/l
*Mercury	0.005	mg/l
Total dissolved solids	750.00	mg/l

*The sum of the entire heavy metal group shall not exceed 1.5 mg/l

c. All substances toxic or detrimental to aquatic life shall be limited to nontoxic or nondetrimental concentrations in the surface water.

d. The fecal coliform content shall not exceed 2,000 organisms per 100 ml., except when the waters are materially affected by surface runoff.

e. The pH shall be not less than 6.5 nor greater than 9.0. The maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units.

f. Temperature.

(1) No heat shall be added to interior streams that would cause an increase of more than 5°F. The rate of temperature change shall not exceed 2°F. per hour. In no case shall heat be added in excess of that amount that would raise the stream temperature above 90°F.

(2) No heat shall be added to streams designated as cold water fisheries that would cause an increase of more than 3°F. The rate of temperature change shall not exceed 2°F. per hour. In no case shall heat be added in excess of that amount that would raise the stream temperature above 68°F.

(3) No heat shall be added to lakes and reservoirs that would cause an increase of more than 3°F. The rate of temperature change shall not exceed 2°F. per hour. In no case shall heat be added in excess of that amount that would raise the temperature of the lake or reservoirs above 90°F.

(4) No heat shall be added to the Missouri river that would cause an increase of more than 5°F. The rate of temperature change shall not exceed 2°F. per hour. In no case shall heat be added that would raise the stream temperature above 90°F.

(5) No heat shall be added to the Mississippi river that would cause an increase of more than 5°F. The rate of temperature change shall not exceed 2°F. per hour. In addition, the water temperature at representative locations in the Mississippi river shall not exceed the maximum limits in the below table during more than one percent of the hours in the 12-month period ending with any month. Moreover, at no time shall the water temperature at such locations exceed the maximum limits in the below table by more than 3°F.

Zone II—Iowa-Minnesota State line to the Northern Illinois border (Mile Point 1534.6)
Zone III—Northern Illinois border (Mile Point 1534.6) to Iowa-MIssouri State line.

Month	Zone II	Zone III	Month	Zone II	Zone III
January	40°F	45°F	July	84°F	86°F
February	40°F	45°F	August	84°F	86°F
March	54°F	57°F	September	82°F	85°F
April	65°F	68°F	October	73°F	75°F
May	75°F	78°F	November	58°F	65°F
June	84°F	85°F	December	48°F	52°F

g. The waters shall contain no substances which will impart any undesirable tastes to fish flesh, or in any other way make fish inedible.

16.3(4) *Class "C" waters.* Waters which are designated as class "C" waters are to be protected as a raw water source of potable water supply. The following criteria shall apply to all class "C" waters:

a. Radioactive substances.

(1) Gross beta activity (in the known absence of strontium-90 and alpha emitters) shall not exceed 1,000 picocuries per liter at the point of withdrawal.

(2) The concentration of radium 226 shall not exceed 3 picocuries per liter at the point of withdrawal.

(3) The concentration of strontium 90 shall not exceed 10 picocuries per liter at the point of withdrawal.

(4) The annual average concentration of specific radionuclides other than 226 radium and 90 strontium, shall not exceed 1/30 of the appropriate maximum permissible concentration for the 168-hour week as set forth by the International Commission of Radiological Protection and the National Committee on Radiation Protection in Handbook 69. The concentrations of radioisotopes in natural waters shall be maintained at the lowest practicable level.

b. Chemical Constituents. The following levels shall not be exceeded at the point of withdrawal:

Arsenic	0.05	mg/1
Barium	1.0	mg/1
Cyanide	0.025	mg/1
Cadmium	0.01	mg/1
Copper	1.0	mg/1
Fluoride	1.5	mg/1
Lead	0.05	mg/1
Phenols (From other than natural sources)	0.001	mg/1
Chlorides	250.0	mg/1
Total dissolved solids	750.0	mg/1
Chromium (Hexavalent)	0.05	mg/1
Mercury	0.005	mg/1
Nitrate (NO_3)	45.0	mg/1
Selenium	0.01	mg/1
Zinc	1.0	mg/1

The sum of Lead, Cadmium, Hexavalent Chromium, Mercury and Selenium shall not exceed 1.5 mg/1.

c. All substances toxic or detrimental to humans or detrimental to treatment process shall be limited to nontoxic or nondetrimental concentrations in the surface water.

d. The pH shall not be less than 6.5 nor greater than 9.0.

APPENDIX D

ICP-CBP Wildlife Survey Data

by Janet Voight

TABLE DI

REPTILES AND AMPHIBIANS LIKELY TO BE FOUND IN THE IMPACT AREA

REPTILES:

Species	Abundance in state	Habitat
Common snapping turtle *Chelydra serpentina*	common	ponds and lakes
Western painted turtle *Chrysemys picta*	common	shallow, muddy ponds and marshes
Ornate box turtle *Terrapene ornata*	rare	grasslands, esp. sandy
Northern water snake - P* *Natrix sipedon*	common	any body of water esp. quiet water
Graham's water snake - P *Natrix grahamii*	occasional	protected water edges
Red-sided garter snake *Thamnophis sirtalis*	abundant	wide range of grass-lands and woods
Plains garter snake *Thamnophis radix*	common	near water in grasslands
DeKay's snake *Storeria dekayi*	common	moist areas
Eastern hognose snake *Heterodon platyrhinos*	common	sandy woods and open areas
Prairie ringneck snake - P *Diadophis punctatus*	common	rocky open woods
Smooth green snake *Opheodrys vernalis*	common	moist grasslands

* P = Possibly

Eastern yellow-bellied racer *Coluber constrictor*	common	fields, brush, open woods
Bull snake *Pituophis melanoleucus*	common	grasslands
Fox snake *Elaphe vulpina*	common	open moist grass- lands and woods
Red milk snake *Lampropeltis triangulum*	common	open agricultural land and woodlands

AMPHIBIANS:

Species	Abundance in state	Habitat
Mudpuppy *Necturus maculosus*	common	permanent water
Eastern tiger salamander *Ambystoma tigrinum*	common	ponds
American toad *Bufo americanus*	abundant	anywhere with enough water for breeding
Tree frog *Hyla versicolor*	common	trees in or near water
Western chorus frog *Pseudacris triseriata*	common	agricultural fields and praries
Blanchard's cricket frog *Acris crepitans*	common	river valleys and lowlands
Bullfrog *Rana catesbeiana*	common	any permanent water
Green frog *Rana clamitans*	common	shallow water- standing or running
Leopard frog *Rana pipiens*	occasional	open meadows

TABLE D2

BIRDS OF THE ICP BENEFICIATION PLANT IMPACT AREA

Species	Residence Status	Abundance	Habitat
Green heron - P* *Butorides virescens*	summer	common	marsh, swamp
Mallard - P *Anas platyrhychos*	summer, transient	abundant	marsh, swamp
Black duck - P *Anas rubripes*	winter, transient	uncommon	marsh, swamp
Blue-winged teal - P *Anas discors*	summer, transient	abundant	marsh, swamp
Kestrel - S *Falco sparverius*	permanent, summer	common	pasture, prairi fields
Bobwhite quail - P *Colinus virginianus*	permanent	common	cropland, pastu prairie, old fields
Ring-necked pheasant - E *Phasianus colchicus*	permanent	abundant	cropland, pastu prairie, fields
Virginia Rail - P *Rallus limicola*	summer	common	marsh
Sora - P *Porzana carolina*	summer	uncommon	marsh
American coot - P *Fulica americana*	summer	common	aquatic, marsh
Semi-palmated plover - P *Charadrius semipalmatus*	transient	uncommon	shores
Killdeer - S *Charadrius vociferus*	summer	abundant	cropland

*S - Seen, E - Expected, P - Possible

American golden plover *Pluvialis dominica*	transient	common	cropland, pastu
Black-bellied plover *Squatarola squatarola*	transient	uncommon	cropland, pastu
American woodcock - S *Philohela minor*	summer	uncommon	swamp, riparian
Common snipe - P *Capella gallinago*	winter, transient	common	marsh, swamp
Upland plover - P *Bartramia longicauda*	summer	uncommon	pasture, prairi old field
Spotted Sandpiper - E *Actitis macularia*	summer	common	shores
Solitary sandpiper - P *Tringa solitaria*	transient	common	shores
Greater Yellowlegs - P *Totanus melanoleucus*	transient	common	shores
Lesser Yellowlegs - P *Totanus flavipes*	transient	common	shores
Pectoral sandpiper - P *Erolia melanotos*	transient	abundant	marsh, shores
White-rumped sandpiper - P *Erolia fuscicollis*	transient	uncommon	shores
Baird's sandpiper -P *Erolia bairdii*	transient	uncommon	shores
Least sandpiper -P *Erolia minutilla*	transient	common	shores
Semipalmated sandpiper - P *Ereunetes pusillus*	transient	common	shores
Rock dove - S *Columba livia*	permanent	abundant	cropland, pastu
Mourning dove - S *Zenaidura macroura*	permanent, summer	abundant	cropland, pastu old fields, fore edge
Yellow-billed cuckoo - S *Coccyzus americanus*	summer	common	forest edge

Black-billed cuckoo - E Coccyzus erytropthalmus	transient	common	forest edge
Barn owl - E Tyto alba	permanent	rare	cropland, pastu prairie, old fields, forest edge
Screech owl - E Otus asio	permanent	common	old fields, for edge
Great-horned owl - S Bubo virginianus	permanent	common	prairie, old fields, forest edge
Barred owl - S Strix varia	permanent	common	riparian, decid ous forest
Long-eared owl - P Asio otus	permanent, winter	occasional	deciduous fores
Short-eared owl - E Asio flammeus	permanent, winter	uncommon	pasture, prairi old fields
Common nighthawk - S Chordeiles minor	summer	abundant	pasture, prairi old fields
Chimney swift - S Chaetura pelagica	summer	abundant	pasture, prairi old fields
Ruby-throated hummingbird - S Archilochus colubris	summer	common	prairie, old fields, forest edge
Belted kingfisher - S Magaceryle alcyon	summer	common	streamedge
Flicker - S Colaptes auratus	permanent, summer	abundant	pasture, prairi old fields, for edge
Red-bellied woodpecker - S Centurus carolinus	permanent	common	riparian, fores edge
Red-headed woodpecker - S Melanerpes erythro- cephalus	permanent, summer	abundant	pasture, old fields
Yellow-bellied sapsucker - S Sphyrapicus varius	transient	common	deciduous forest

Hairy woodpecker - E Dendrocopus villosus	permanent	common	riparian, deciduous fores
Downy woodpecker - S Dendrocopus pubescens	permanent	abundant	riparian, diciduous fores
Eastern kingbird - E Tyrannus tyrannus	summer	abundant	old fields, forest edge
Great crested flycatcher - E Myiarchus crinitus	summer	common	forest edge
Eastern phoebe - E Sayornis phoebe	summer	common	old fields, forest edge
Traill's flycatcher - S Empidonax traillii	summer	common	riparian
Least flycatcher - E Empidonax minimus	transient	common	old fields, forest edge
Eastern wood pewee - S Contopus virens	summer	common	forest edge
Horned lark - E Eremophila alpestris	permanent	abundant	cropland, pastu prairie, old fields
Tree swallow - E Iridoprocne bicolor	summer	uncommon	swamp, riparian
Bank swallow - E Riparia riparia	summer	abundant	riparian
Rough-winged swallow - E Stelgidopteryx ruficollis	summer	common	cliffs, banks
Barn swallow - E Hirundo rustica	summer	abundant	cropland, old fields, pasture
Cliff swallow - E Petrochelidon pyrrhonota	summer	uncommon	urban, cliffs
Purple martin - E Progne subis	summer	common	cropland, pastur
Blue-jay - S Cyanocitta cristata	summer, permanent	abundant	pasture, old fields, forest edge

Common crow - S Corvus brachyrhynchos	permanent	abundant	cropland, fores edge, prairie, pasture
Black-capped chick-a-dee - S Parus atricapillus	permanent	abundant	old fields, for edge
Tufted titmouse - S Parus bicolor	permanent	common	old fields, for edge
White-breasted nuthatch - S Sitta carolinensis	permanent	abundant	forest edge
Brown creeper - S Certhia familiaris	permanent, winter	uncommon	forest edge
House wren - S Troglodytes aedon	summer	abundant	forest edge
Winter wren - E Troglodytes troglodytes	transient	occasional	riparian
Carolina wren - E Thryothorus ludovicianus	transient	rare	forest edge
Long-billed marsh wren - P Telmatodytes palutris	summer	common	marsh
Short-billed marsh wren - P Cistothorus platensis	summer	uncommon	marsh, prairie
Mockingbird - E Mimus polyglottus	summer	uncommon	old fields, forest edge
Catbird - S Dumetella carolinensis	summer	abundant	forest edge
Brown thrasher - S Toxostoma rufum	summer	abundant	old fields, forest edge
Robin - S Turdus migratorius	permanent, summer	abundant	pasture, prairie old fields
Wood thrush - E Hylocichla mustelina	summer	common	forest edge
Eastern bluebird - E Sialia sialis	permanent, summer	common	old fields, fore edge

Golden-crowned kinglet - S *Regulus satrapa*	transient	common	deciduous fore:
Ruby-crowned kinglet - S *Regulus calendula*	transient	common	deciduous fore:
Bohemian waxwing - P *Bombycilla garrulus*	winter	rare	old fields, forest edge
Cedar waxwing - S *Bombycilla cedrorum*	summer	uncommon	old fields, forest edge
Loggerhead shrike - E *Lanius ludovicianus*	summer	uncommon	prairie, old fields
Starling - S *Sturnus vulgaris*	permanent	abundant	cropland, pastu old fields, urb forest edge
White-eyed vireo - E *Vireo griseus*	summer	rare	forest edge
Bell's vireo - E *Vireo bellii*	summer	common	riparian
Yellow-throated vireo - E *Vireo flavifrons*	summer	common	forest edge
Red-eyed vireo - E *Vireo alivaceus*	summer	abundant	forest edge
Philadelphia vireo - E *Vireo philadelphicus*	transient	rare	forest edge
Warbling vireo - E *Vireo gilvus*	summer	abundant	forest edge
Black and white warbler - S *Mniotilta varia*	transient	common	forest edge
Golden-winged warbler - S *Vermivora chrysoptera*	transient	rare	forest edge
Blue-winged warbler - E *Vermivora pinus*	summer	rare	forest edge
Tennessee warbler - E *Vermivora peregrina*	transient	abundant	swamp, deciduou: forest

Orange-crowned warbler - E *Vermivora celata*	transient	common	old field, fore edge
Nashville warbler - S *Vermivora ruficapilla*	transient	common	forest edge
Parula warbler - P *Parula americana*	transient	rare	riparian
Yellow warbler - S *Dendroica petechia*	summer	abundant	riparian, fores edge
Magnolia warbler - E *Dendroica magnolia*	transient	common	forest edge
Cape May warbler - E *Dendroica tigrina*	transient	rare	forest edge
Myrtle warbler - S *Dendroica coranata*	transient	abundant	forest edge
Black-throated green warbler -E *Dendroica virens*	transient	uncommon	swamp
Cerulean warbler - E *Dendroica cerulea*	summer	rare	riparian, deciduous fores
Blackburnian warbler - E *Dendroica fusca*	transient	uncommon	forest edge
Chestnut-sided warbler - E *Dendroica pennsylvanica*	transient	common	forest edge
Black poll - E *Dendroica striata*	transient	common	forest edge
Northern waterthrush - E *Seiurus noveboracensis*	transient	common	swamp, riparian
Lousiana waterthrush - E *Seiurus motacilla*	summer	uncommon	swamp, riparian
Kentucky warbler - E *Oporornis formosus*	summer	uncommon	riparian forest edge
Mourning warbler - E *Oporornis philadelphia*	transient	uncommon	riparian, forest edge
Yellowthroat - S *Geothlypis trichas*	summer	abundant	riparian, old field, forest edge

Yellow-breasted chat - E Icteria virens	summer	uncommon	forest edge
Hooded warbler - E Wilsonia citrina	transient	rare	riparian, deciduous fores
Wilson's warbler - E Wilsonia pusilla	transient	common	riparian, deciduous fores
Canada warbler - E Wilsonia canadensis	transient	uncommon	riparian
American redstart - E Setophaga ruticilla	summer	abundant	forest edge
House sparrow - S Passer domesticus	permanent	abundant	cropland, pastu old fields, forest edge, urban
Bobolink - E Dolichonyx oryzivorus	summer	common	pasture, prairi old fields
Eastern meadowlark - E Sturnella magna	summer	abundant	cropland, pastu old fields
Western meadowlark - E Sturnella neglecta	summer	common	cropland, pastu old fields
Yellow-headed blackbird - P Xanthocephalus xanthocephalus	summer	common	marsh
Red-winged blackbird - S Agelaius phoeniceus	summer, permanent	abundant	marsh, cropland pasture, old fields, forest edge
Orchard oriole - E Icterus spurius	summer	occasional	old field, fore edge
Baltimore oriole - S Icterus galbula	summer	abundant	forest edge
Rusty blackbird - E Euphagus carolinus	transient	common	riparian, forest edge
Brewer's blackbird - E Euphagus cyanocephalus	transient	uncommon	prairie, old fields

Common grackle - S Quiscalus quiscala	permanent,	abundant	pasture, prairi old fields, forest edge
Brown-headed cowbird - S Molothrus ater	summer	common	cropland, pastu: prairie, old fields, forest edge
Scarlet tanager - E Piranga olivacea	summer	uncommon	forest edge
Summer tanager - E Piranga rubra	summer	uncommon	forest edge
Cardinal - S Richmondena cardinalis	permanent	abundant	old fields, forest edge
Rose-breasted grosbeak - S Pheucticus ludovicianus	summer	common	riparian, forest edge
Indigo bunting - S Passerina cyanea	summer	common	old fields, forest edge
Dickcissel - E Spiza americana	summer	abundant	pasture, prairie old fields
Evening grosbeak - E Hesperiphona vespertina	winter, transient	occasional	forest edge
Purple finch - E Carpodacus purpureus	winter	common	forest edge
Common redpoll - E Acanthis flammea	winter	uncommon	prairie, old field, forest ed
American goldfinch - E Spinus tristis	permanent	common	pasture, prairie old fields
Rufus-sided towhee - E Pipilo erythrophthalmus	summer	common	forest edge
Savannah sparrow - E Passerculus sandwichensis	summer, transient	common	prairie, old fields
Grasshopper sparrow - E Ammodramus savannarum	summer	common	pasture, prairie, old fields

LeConte's sparrow - E *Passerherbulus caudacutus*	transient	uncommon	marsh, prairie
Henslow's sparrow - E *Passerherbulus henslowii*	summer	rare	prairie, old fields
Sharp-tailed sparrow - E *Ammospiza caudacuta*	transient	rare	marsh
Vesper sparrow - E *Pooecetes gramineus*	summer	common	pasture, prairi old fields
Lark sparrow - E *Chondestes grammacus*	summer	common	pasture, prairi old fields
Slate-colored junco - S *Junco hyemalis*	winter	abundant	forest edge
Tree sparrow - S *Spizella arborea*	winter	abundant	forest edge
Chipping sparrow - S *Spizella passerina*	summer	common	forest edge
Clay-colored sparrow - E *Spizella pallida*	transient	uncommon	prairie, forest edge
Field sparrow - E *Spizella pusilla*	summer	common	pasture, old field, forest edge
Harris' sparrow - E *Zonotrichia querula*	winter, transient	occasional	old fields, forest edge
White-crowned sparrow - E *Zonotrichia leucophrys*	winter, transient	uncommon	old fields, forest edge
White-throated sparrow - E *Zonotrichia albicollis*	transient	abundant	old fields, forest edge
Fox sparrow *Passerella iliaca*	transient	common	old fields, forest edge
Lincoln's sparrow *Melospiza lincolnii*	transient	common	riparian, forest edge
Swamp sparrow *Melospiza georgiana*	summer, transient	common	swamp, riparian forest edge

Song sparrow - S *Melospiza melodia*	Permanent	abundant	prairie, forest edge, old fields
Lapland long spur - E *Calcarius lapponicus*	winter,	uncommon	cropland, prairie, pastur

TABLE D3

TERRESTRIAL MAMMALS OF THE ICP BENEFICIATION PLANT IMPACT AREA

Species	Abundance	Habitat
Opossum - E* Dipelphis marsupialis	common	woodland
Short-tailed shrew - C Blarina brevicauda	abundant	mesic grasslands
Least shrew - E Cryptotis parva	rare	grasslands with brush
Masked shrew - C Sorex cinereus	occassional	grasslands & fencerows
Eastern mole - E Scalopus aquaticus	occassional	grasslands
Cotton tail rabbit - S Sylvilagus floridanus	abundant	grasslands & brush
Woodchuck - P Marmota monax	occasional	grasslands
Thirteen-lined ground squirrel - S Spermophilus tridecemlineatus	abundant	grasslands
Eastern chipmunk - S Tamias striatus	occassional	woods & brush
Fox squirrel - S Sciurus niger	common	woodland
Grey squirrel - S Sciurus carolinensis	occassional	forest with nut trees
Plains pocket gopher - E Geomys bursarius	common	grasslands
Meadow jumping mouse - E Zapus hudsonius	rare	mesic grasslands & open areas

Western Harvest mouse - C *Reithrodontomys megalotis*	occasional	mesic grasland
Deer mouse - E *Peromyscus maniculatus*	common	drier grasslands and open woods
White-footed mouse - C *Peromyscus leucopus*	abundant	woods and brush
Meadow vole - C *Microtus pennsylvanicus*	occasional	mesic grasslands
Prairie vole - E *Microtus ochrogaster*	rare	dry grasslands
Southern bog lemming - P *Synaptomys cooperi*	rare	wet grasslands
Muskrat - S *Ondatra zibethica*	occasional	stream edges
House mouse - C *Mus musculus*	common	fields, near human habitation
Norway rat - E *Rattus norvegicus*	common	near human habitation
Raccoon - S *Procyon lotor*	occasional	woods with access to water
Domestic dog - S *Canis familiarus*	common	any habitat
Grey fox *Urocyon cinereoargenteus*	rare	woods edge
Red fox - E *Vulpes fulva*	occasional	hilly areas with mosiac woods and open areas
Mink - S *Mustela vision*	occasional	along water
Long-tailed weasel - E *Mustela frenata*	occasional	along water
Striped skunk - E *Mephitis mephitis*	common	open woods, prairie and brush

Spotted skunk - E *Spilogale putorius*	occasional	open woods, prairies and brush
Domestic cat - E *Felis domesticus*	common	any habitat

* S - Seen
C - Captured
E - Expected
P - Possible

TABLE D4

Species Totals of Small Mammals Captured in the Iowa Coal Project Beneficiation Plant Area

Species	Total Captures	Sex Ratio Male:Female*	Age Ratio Adult:Subadult:Juvenile*	Captures per 100 Trap Nights
Peromyscus leucopus	14	9 : 5	11 : 2 : 1	2.65
Blarina brevicauda	13	5 : 8	13 : 0 : 0	2.46
Sorex cinereus	4	-	-	0.76
Microtus pennsylvanicus	3	-	-	0.57
Reithrodontomys megalotis	1	-	-	0.19
Mus musculus	1	-	-	0.19

* Age and sex ratios become increasingly meaningless with capture sizes less than 12.

TABLE D5

Small Mammal Captures per Habitat in the Iowa Coal Project Beneficiation Plant Area

Habitat	Number of Captures	Species	Captures per Habitat per 100 Trap Nights
Beneficiation Plant Vicinity	2	*Blarina brevicauda* short-tailed shrew	2.34
	1	*Sorex cinereus* masked shrew	
Brushy Field, East of the Horticulture Gardens	2	*Sorex cinereus* masked shrew	4.0
	1	*Blarina brevicauda* short-tailed shrew	
	1	*Mus musculus* house mouse	
Stream Bed, South of the C & NW Railroad Right-of-way	8	*Blarina brevicauda* short-tailed shrew	12.7
	7	*Peromyscus leucopus* white-footed mouse	
	3	*Microtus pennsylvanicus* meadow vole	
	1	*Reithrodontomys megalotis* western harvest mouse	
North Side of the C & NW Railroad Right-of-Way	7	*Peromyscus leucopus* white-footed mouse	6.67
	2	*Blarina brevicauda* short-tailed shrew	
	1	*Sorex cinereus* masked shrew	

REFERENCES

(1) Akhavi, M.S., 1970. Occurrence, Movement and Evaluation of Shallow Groundwater in the Ames, Iowa Area. Unpublished Ph. D. Thesis. Ames, Iowa, Library, Iowa State University of Science and Technology.

(2) American Public Health Association, 1965. Standard Methods for the Examination of Water and Wastewater, 12th ed. Washington, D.C.

(3) Backsen, L.B., 1963. Geohydrology of the Aquifer Supplying Ames, Iowa. Unpublished M.S. Thesis. Ames, Iowa, Library, Iowa State University of Science and Technology.

(4) Battelle, Columbus Laboratories, 1973. Detailed Environmental Analysis Concerning a Proposed Coal Gasification Plant and the Expansion of a Strip Mine Operation Near Burnham, New Mexico. Columbus, Ohio.

(5) Bolt Beranek and Newman, Inc., 1974. Coal Cleaning Plant Noise and Its Control. Prepared for Bureau of Mines, NTIS, U.S. Department of Commerce.

(6) Brown, W.H., 1971. An Annotated List of the Birds of Iowa. Iowa State Journal of Science, 45: 387-469.

(7) Conant, R., 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 2nd ed. Boston, Massachusetts. Houghton, Mifflin.

(8) Department of the Army, Corps of Engineers, 1973. Application for Permit to Discharge or Work in Navigable Waters and Their Tributaries by Iowa State University, Ames, Iowa.

(9) Energy and Mineral Resources Research Institute, R.S. Hansen director, 1976. Iowa Coal Research Project Second Annual Progress Report. Iowa State University, Ames, Iowa.

(10) Glenn-Lewin, D.C., 1975. Terrestrial Environmental Impact of Electrical Generating Plant, Ottumwa, Iowa. Consultant to Black and Vetch.

(11) Iowa Department of Environmental Quality, 1976. Unpublished Air Quality Data. Des Moines, Iowa.

(12) Martin, J.F., 1974. Quality of Effluents from Coal Refuse Piles. Pages 26-37 in First Symposium on Mine and Preparation Plant Refuse Disposal. National Coal Association. Washington, D.C.

REFERENCES

(13) Menzel, B.W., 1975. Unpublished Course Manual for Zoology 306, Herptology. Iowa State University, Ames, Iowa.

(14) Mining Enforcement and Safety Administration, revised July 1, 1975. Excerpts from Code of Federal Regulations Title 30, Mineral Resources. U.S. Government Printing Office.

(15) Moore, K., 1976. Unpublished Vegetation Survey. Terrestrial Environment Team, Iowa Coal Project. Ames, Iowa.

(16) National Coal Association, 1974. First Symposium on Mine and Preparation Plant Refuse Disposal. Washington, D.C.

(17) National Oceanic and Atmospheric Administration, Environmental Data Service, 1975. Climatological Data, Iowa. vol. 86, Ashville, North Carolina.

(18) Nicklin, M., 1974. The Hydrogeology of the Regolith Aquifer Supplying the Iowa State University Well Field. Unpublished M.S. Thesis. Ames, Iowa, Library, Iowa State University of Science and Technology.

(19) Pettyjohn, W.A. ed., 1972. Water Quality in a Stressed Environment. Minneapolis, Minnesota. Burgess Publishing Co.

(20) Robbins, C.S., B. Bruun, and H.S. Zim, 1966. A Guide to Field Identification, Birds of North America. New York, New, York. Golden Press.

(21) U.S. Department of Agriculture, 1975. Draft Environmental Statement for Veterinary Biologics Laboratory Ames, Iowa. Animal and Plant Health Inspection Service, Washington, D.C.

(22) U.S. Department of Agriculture, 1951. Soil Survey Manual, USDA Handbook No. 18. Superintendant of Documents, Washington, D.C.

(23) U.S. Department of Agriculture, Soil Conservation Service, 1967. Soil Survey Information and Interpretations. Lincoln, Nebraska.

(24) U.S. Department of Interior, Geological Survey, 1973. Water Resources Data for Iowa. U.S. Geological Survey, Iowa City, Iowa.

REFERENCES

(25) U.S. Environmental Protection Agency, 1974. Background Information for Standards of Performance: Coal Preparation Plants, Volume 1: Proposed Standards. Research Triangle Park, North Carolina.

(26) U.S. Environmental Protection Agency, 1973. Environmental Impact Statement Guidelines. U.S. Government Printing Office, Washington, D.C.

(27) Vawter, 1963. Elevations and Frequency of Occurrence of Floods in Squaw Creek Basin in Ames, Iowa. Unpublished M.S. Thesis. Ames, Iowa, Library, Iowa State University of Science and Technology

(28) Voight, J., 1976. Unpublished ICP-CBP Wildlife Survey. Terrestrial Environment Team, Iowa Coal Project, Ames, Iowa.